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Technical Report HL-95-4
July 1995

Field Data Collection Report, Cape Fear River, Wilmington, North Carolina

by Howard A. Benson, Joseph W. Parman

Prepared for U.S. Army Engineer District, Wilmington

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U.S. Army Corps of Engineers
Waterways Experiment Station
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

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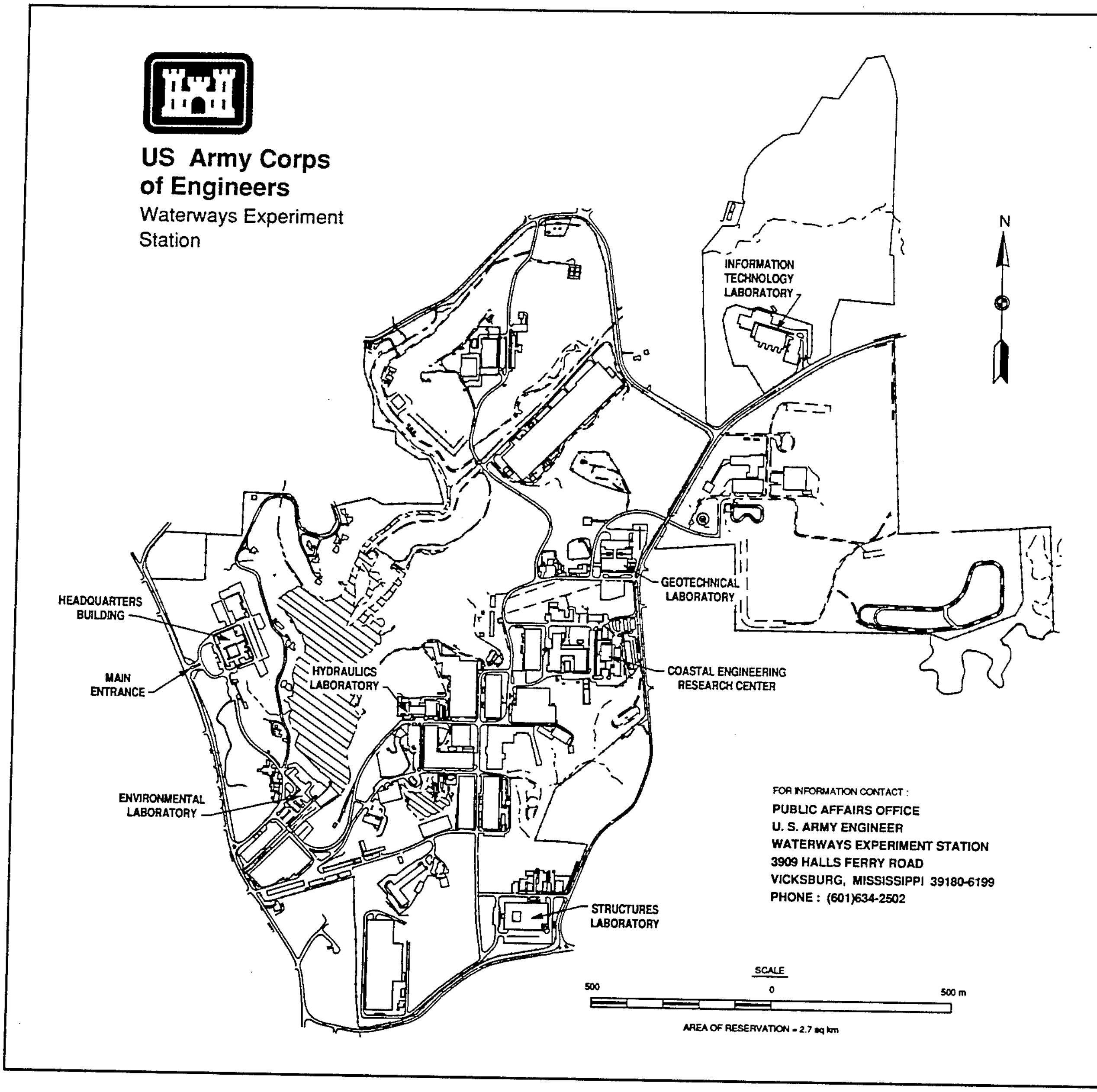

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Contents

Preface

The work described in this report was performed by the Hydraulics Laboratory (HL) of the U.S. Army Engineer Waterways Experiment Station (WES) from mid-August 1993 through mid-October 1993 as a part of the Comprehensive Hydrodynamic Modeling Investigation for the Cape Fear River/Wilmington Harbor, North Carolina. The work for the Cape Fear River Study was conducted for the U.S. Army Engineer District, Wilmington, and managed by Mr. Mike Wutkowski, Wilmington District.

This study was conducted under the direction of Messrs. Frank A. Herrmann, Jr., Director, HL; Richard A. Sager, Assistant Director, HL; William H. McAnally, Jr., Chief, Estuaries Division (ED), HL; George M. Fisackerly, Chief, Estuarine Processes Branch (EPB), ED; and Mr. William D. Martin, Chief, Estuarine Engineering Branch (EEB), ED. Dr. Robert T. McAdory, Jr., EEB, served as the point of contact (POC) for all WES activities during the study. Mr. Mike Wutkowski served as POC for the Wilmington District.

The field data collection portion of the project study was designed by Messrs. Timothy L. Fagerburg, Howard A. Benson, and Joseph W. Parman (retired), all of EPB, and Dr. McAdory, and executed under the direction of Messrs. Fagerburg and Benson. Other WES personnel participating in the data collection were Messrs. Samuel E. Varnell, Thad C. Pratt, Gregory H. Nail, and Byron M. Reed, all of EPB; and David Ballard, Paul T. Puckett, Douglas C. Lee, and Troy D. Nelson, all of the Coastal Engineering Research Center (CERC) at WES. Assistance was also provided by Capt. Steve Beuth and the crew of the R/V *Dan Moore*, all of Cape Fear Community College. Data reduction was performed by Ms. Clara J. Coleman, EPB, and Messrs. Pratt, Reed, and Parman. Laboratory analysis of water samples was performed by Ms. Coleman and Mr. Parman. This report was prepared by Messrs. Benson and Parman.

Dr. Robert W. Whalin was Director of WES during the publication of this report. COL Bruce K. Howard, EN, was Commander.

Conversion Factors, Non-SI to SI Units of Measurement

Non-SI units of measurements used in this report can be converted to SI units as follows:

Multiply	By	To Obtain
cubic feet	0.02831685	cubic metres
degrees (angle)	0.01745329	radians
feet	0.3048	metres
inches	2.54	centimetres
knots (international)	0.5144444	meters per second
miles (U.S. statute)	1.609347	kilometres
ounces (U.S. fluid)	0.02957353	cubic decimeters
pounds (force)	4.448222	newtons
square miles	2.589998	square kilometres
Fahrenheit degrees	[1]	Celsius degrees

[1] To obtain Celsius (C) temperature readings from Fahrenheit (F) readings, use the following formula: C = (5/9)(F-32). To obtain kelvin (K) readings, use: K = (5/9)(F - 32) + 273.15.

1 Introduction

Project Description

The Cape Fear River estuarine system includes the lower Cape Fear and Northeast Cape Fear Rivers. This is the only major estuary in North Carolina that has a relatively free and direct access to the ocean. The study area covers portions of three counties, Brunswick, New Hanover, and Pender, in southeastern North Carolina (Figure 1).

The project area includes the Cape Fear River estuary, from the ocean entrance between Oak Island to the west and Bald Head Island to the east. The river winds approximately 65 miles[1] upstream from the mouth near Southport to Lock and Dam 1. The area also includes approximately 25 miles of the Black River from the Highway 11 bridge to where it joins the Cape Fear River above Navassa, and approximately 25 miles of the Northeast Cape Fear River from Castle Hayne to Wilmington. The study area covers approximately 400 square miles and is used for fish and wildlife interests as well as for shipping and navigation.

Tidal effects extend up to Lock and Dam 1 in the Cape Fear River and approximately 48 miles upstream of Wilmington on the Northeast Cape Fear River. Semidiurnal tides and associated estuarine processes respond primarily to a fortnightly lunar cycle. Mean and spring tidal ranges typically vary from 4.3 to 4.9 ft, respectively, at Bald Head, and 4.1 to 4.5, respectively, at Wilmington. The Cape Fear River estuary long-term average freshwater discharge is 11,000 cfs with seasonal high flows averaging about 18,000 cfs, and seasonal low flows averaging about 1,000 cfs. These lunar and seasonal discharge variations result in rather complex and dynamic estuarine salinity and circulation characteristics. The Cape Fear River estuary is generally considered a partially mixed estuarine system. However, the system actually cycles through periods of well-mixed to partially stratified conditions depending on the location within the system, the freshwater discharge, and the tidal phase.

[1] A table of factors for converting non-SI units of measurement to SI units is found on page vi.

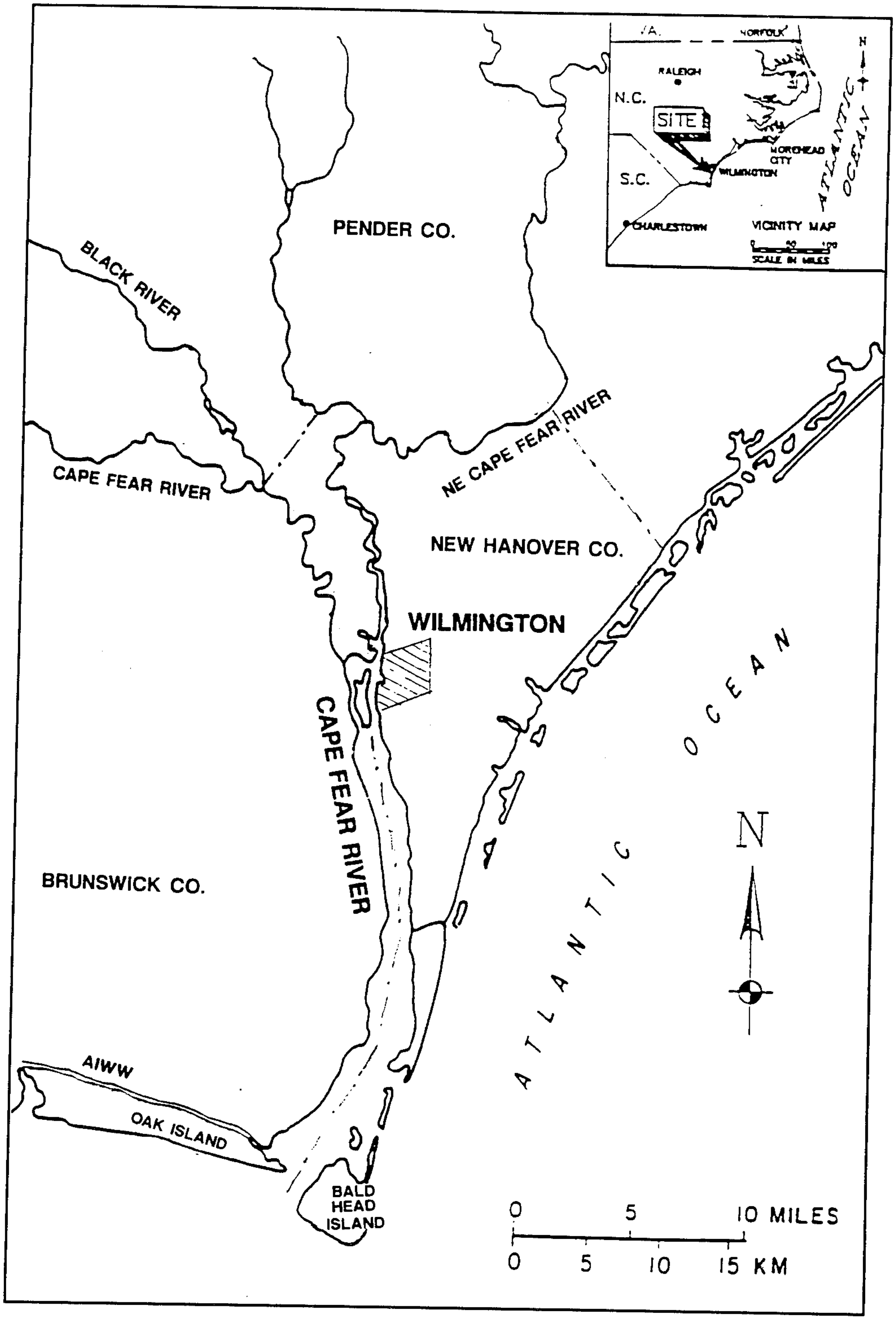


Figure 1. Location and vicinity maps

The climate of the area is generally mild due to the influence of the ocean and the Gulf Stream located about 45 miles offshore. Seasons are mild with a mean average temperature of 63 °F, and average rainfall of about 51 in.

The Cape Fear River estuary is an important navigable waterway and provides a vital link in the flow of marine commerce to the state of North Carolina. Commercial shippers, commercial fishermen, and recreation vessels use the waterway extensively. The existing depth of the channel has been cited as the most limiting aspect of Wilmington Harbor. Shippers, the State Port Authority, and pilots have been requesting deeper channels to improve the overall efficiency of port operations. With the authorized channel depth of 35 ft, pilots can bring ships in on high tide with drafts of 38 ft and leave on high tide with drafts of 37 ft. This practice requires careful scheduling with associated time delays to take advantage of the additional high water levels. Shipping interests have expressed a need for an optimum channel configuration that would reduce vessel delays, decrease transportation costs, and allow the port to keep up with the trend toward larger vessels.

The U.S. Army Engineer District, Wilmington, requested the Estuaries Division, Hydraulics Laboratory, U.S. Army Engineer Waterways Experiment Station (WES), to conduct a three-dimensional (3-D) hydrodynamic model study of the planned deepening of the Cape Fear River navigation channel including a comprehensive field data collection effort. This study was to assist the Wilmington District in formulating the project design and assessing interior Cape Fear River/Wilmington Harbor potential impacts on river and tidal currents and salinity intrusion due to project construction.

Purpose

The purpose of the overall study was to predict the effects due to project construction on water levels, tidal current magnitudes and direction, circulation patterns, salinity intrusion and distribution, and other potential hydrodynamic changes associated with the proposed project deepening of the Cape Fear River. The purpose of the field data collection program was to provide the necessary field data needed for the numerical modeling prediction efforts.

Scope

This report presents representative results of the field data collection program in the Cape Fear River estuary from mid-August 1993 through mid-October 1993. Measurements consisted of the following:

a. Long-term

(1) Water levels and near-surface salinity and temperature at 11 locations.

(2) Fixed-depth current speed, current direction, temperature, and salinity at 10 locations.

b. Short-term

(1) Point sample salinities at long-term equipment sites at the start and end of data collection.

(2) Current speed and current direction at 16 data collection ranges.

(3) Salinity and suspended sediment samples at each of the 16 ranges.

This report describes the field investigation methods used to collect the data, shows representative results of the data reduction efforts, and describes the availability of the data for further use.

2 Data Collection Equipment and Program

Data were collected in the Cape Fear River estuary from mid-August 1993 through mid-October 1993. During this period, water level recorders and moored current meters were in place continuously. Long-term equipment deployment (45 days) provided the minimum amount of data necessary to verify the numerical model capabilities. Additional salinity profile measurements were collected at the start and end of the data collection effort. Intensive short-term (one semidiurnal tidal cycle) data were collected with boat-mounted equipment measuring current speed and current direction. Water samples for salinity determination and suspended sediment concentrations were also collected. This data collection effort is described in the subsequent sections of this report.

Equipment and Deployment Locations

Long-term water level measurements

During the Cape Fear River field investigation, 13 water level recorders were deployed at eleven locations shown in Figure 2. Two critical locations were identified prior to the deployment of the instruments, and a redundant recorder was installed at each of these two locations. The locations are identified as stations S1.3A and B (redundant), S2.0, S3.0, S3.5, S4.0, S6.0A and B (redundant), S7.0, S8.0, S9.0, S10.0, and S11.0. The water level elevations were monitored using Environmental Devices Corporation (ENDECO) Type 1152 SSM (Solid-State Memory) water level recorders (described in Appendix A). The 1152 SSM also recorded temperature and salinity. The sampling interval of the 1152 SSM was 15 min for all the recorders.

Stations S1.3A and S1.3B were mounted on the end of the Fort Caswell Pier on Oak Island. Station S2.0 was mounted on channel marker 1 near Southport. Station S3.0 was mounted on a single pile east of Reaves Point near channel marker 24. Station S3.5 was installed on the Snows Cut Bridge fender in the Atlantic Intracoastal Waterway (AIWW). Station S4.0 was

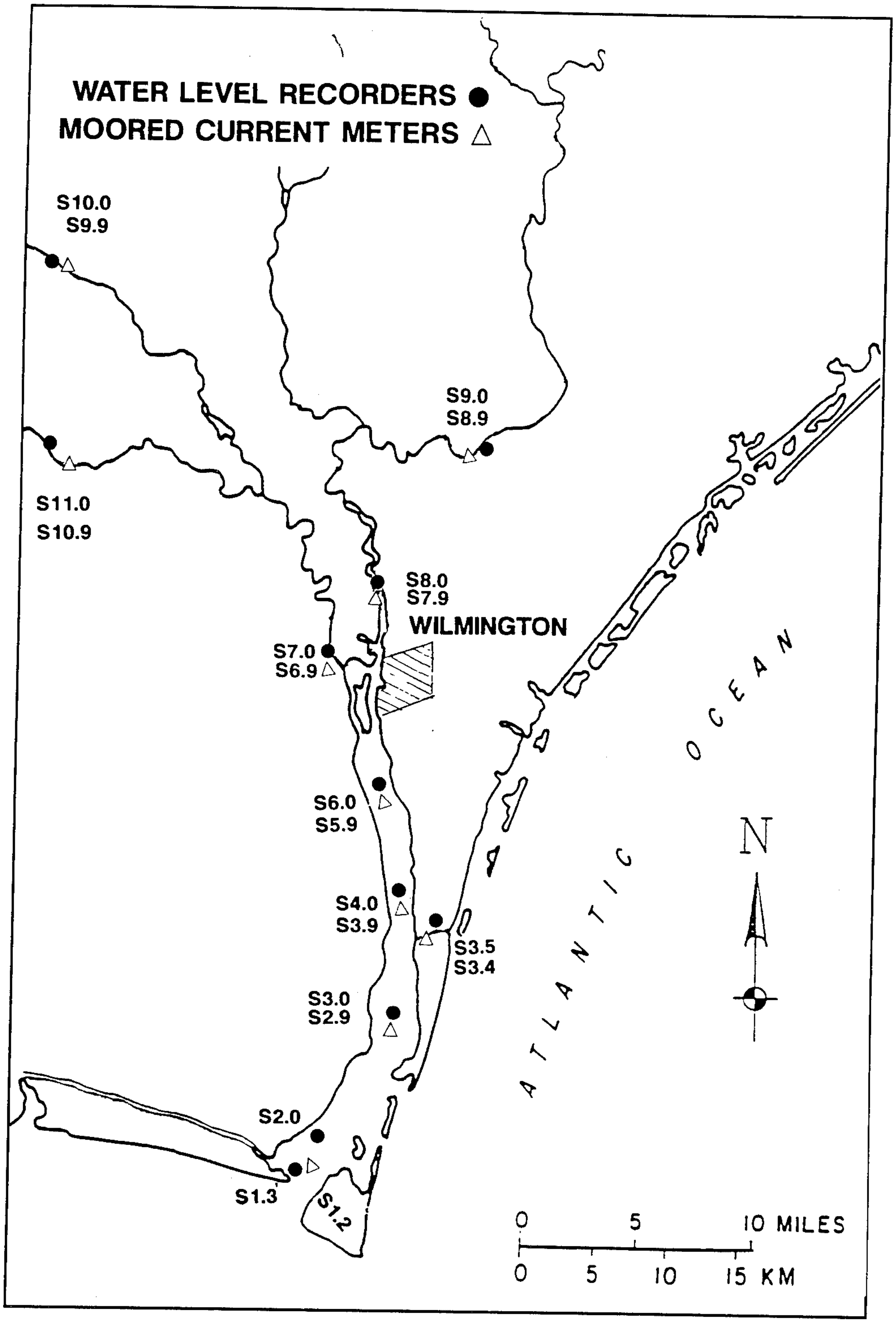


Figure 2. Deployment of water level recorders and moored current meters

installed on the center back range marker off Doctor Point. Stations S6.0A and S6.0B were installed on channel marker 53 near the Exxon Pier. Station S7.0 was installed on the Navassa railroad bridge fender. Station S8.0 was installed on the Hilton railroad bridge fender. Station S9.0 was installed

on the SCL railroad bridge fender at Castle Hayne. Station S10.0 was installed in the Black River just upstream of the Highway 11 bridge. A temporary platform was built and the recorder mounted on it. Station S11.0 was installed on the lock wall at Lock and Dam 1 on the Cape Fear River.

Long-term current meter measurements

Current speed, current direction, temperature, and salinity measurements were recorded using ENDECO model 174 SSM current meters similar to that described in Appendix A. Sixteen current meters were deployed at 10 locations shown in Figure 2. The locations were designated as stations S1.2A and B, S2.9A and B, S3.4, S3.9A and B, S5.9A and B, S6.9A and B, S7.9A and B, S8.9, S9.9, and S10.9. At the 6 locations where two current meters were deployed, the meters were located at middepth and at 5 ft above bottom, and were labeled A and B, respectively. The middepth was referenced to the location depth at low tide levels. At the four locations where just one current meter was deployed, the meter was moored at 5 ft above bottom. The sampling interval of the current meters was 15 min. A typical current meter deployment is shown in Figure A2, Appendix A.

Stations S1.2A and S1.2B were deployed just upstream of the Fort Caswell Pier on the west side of the channel. Stations S2.9A and S2.9B were deployed just south of buoy 24 on the east side of the channel. Station S3.4 was deployed just west of the Snows Cut Bridge in the AIWW. Stations S3.9A and S3.9B were deployed just south of buoy 36 on the east side of the channel. Stations S5.9A and S5.9B were deployed just upstream of channel marker 53 on the west side of the channel. Stations S6.9A and S6.9B were deployed just downstream of the Navassa railroad bridge on the west side of the channel. Stations S7.9A and S7.9B were deployed upstream of the Highway 117 bridge and downstream of the Hilton railroad bridge on the west side of the channel. Station S8.9 was deployed in the center of the Northeast Cape Fear River at Castle Hayne. Station S9.9 was deployed on the east side of the Black River just upstream of the Highway 11 bridge. Station S10.9 was deployed in the center of the Cape Fear River downstream of Lock and Dam 1 and just upstream of the Highway 11 bridge.

Salinity measurements

Water samples for salinity determination were collected at the time of deployment of the water level recorders. Samples were collected at the depth and location of the sensor. Salinity profile measurements, in the center line of the channel near each meter string, were made at the start and end of the data collection. Measurements were obtained using an Aanderaa model 2975 handheld portable salinity sensor with a model 3012 display unit.

Intensive survey current speed and direction measurements

During August 1993, four boats were required to conduct the over-the-side intensive survey at 16 ranges shown in Figure 3. Range R1.0 was located near Fort Caswell. Range R2.0 was located in the Snows March Channel range above buoy 18. Range R3.1 (originally R3.0) was located in the Reaves Point Channel range. This range was moved slightly due to Coast Guard diving operations in the vicinity. Range R4.0 was located in the Lower Midnight Channel range. Range R5.0 was located in the Upper Midnight Channel range. Range R6.0 was located in the Lower Liliput Range near Doctor Point. Range R7.0 was located in the Lower Brunswick Range. Range R8.0 was located in the Between Channel near Dram Tree Point. Range R9.0 was located in the Cape Fear River upstream of Point Peter. Range R10.0 was located in the Northeast Cape Fear River above the turning basin. Range 11.0 was located in the Brunswick River. Range R12.0 was located in the AIWW at Snows Cut. Range R13.0 was located in the AIWW near Southport. Range RSB1 was located in the South Basin of the Military Ocean Terminal at Sunny Point (MOTSU). Range RCB2 was located in the Center Basin at MOTSU, and Range RNB1 was located at the North Basin at MOTSU. The numbering sequence for the ranges followed those of a previous data collection effort (1978-79) in order to maintain consistency in the data collection ranges nomenclature. Each boat covered several ranges over a 2-day period from the entrance to above Wilmington. Current speed and current direction were measured using RD Instruments Direct Reading Acoustic Doppler Current Profilers (ADCP). The ADCP operates by transmitting acoustic pulses (Figure 4) from four transducers, each oriented 30 deg from the vertical at 90-deg intervals in the horizontal plane. The return signals are gated to resolve up to 128 depth increments. The Doppler principal is applied to resolve current components from backscattered acoustic signals. One boat was equipped with a 600-kHz broad-band frequency while the other three boats were equipped with 1,200-kHz broad bands. Additional information on the ADCP is described in Appendix A.

Intensive survey salinity measurements

Discrete water samples for salinity determination were collected at three depths (near-surface, middepth, and near-bottom) across the 16 ranges shown in Figure 3. Ranges R1.0, R2.0, R5.0, R6.0, and R8.0 collected their samples at stations A and C on each range. These sampling stations were located at the quarter-points across the channel with the A station nearest the right descending bank. Samples collected at ranges R3.1, R4.0, R7.0, R9.0, R10.0, R11.0, R12.0, R13.0, RSB1, RCB2, and RNB1 were collected at the center line of each range. Sampling technique and analysis are described in Appendix A.

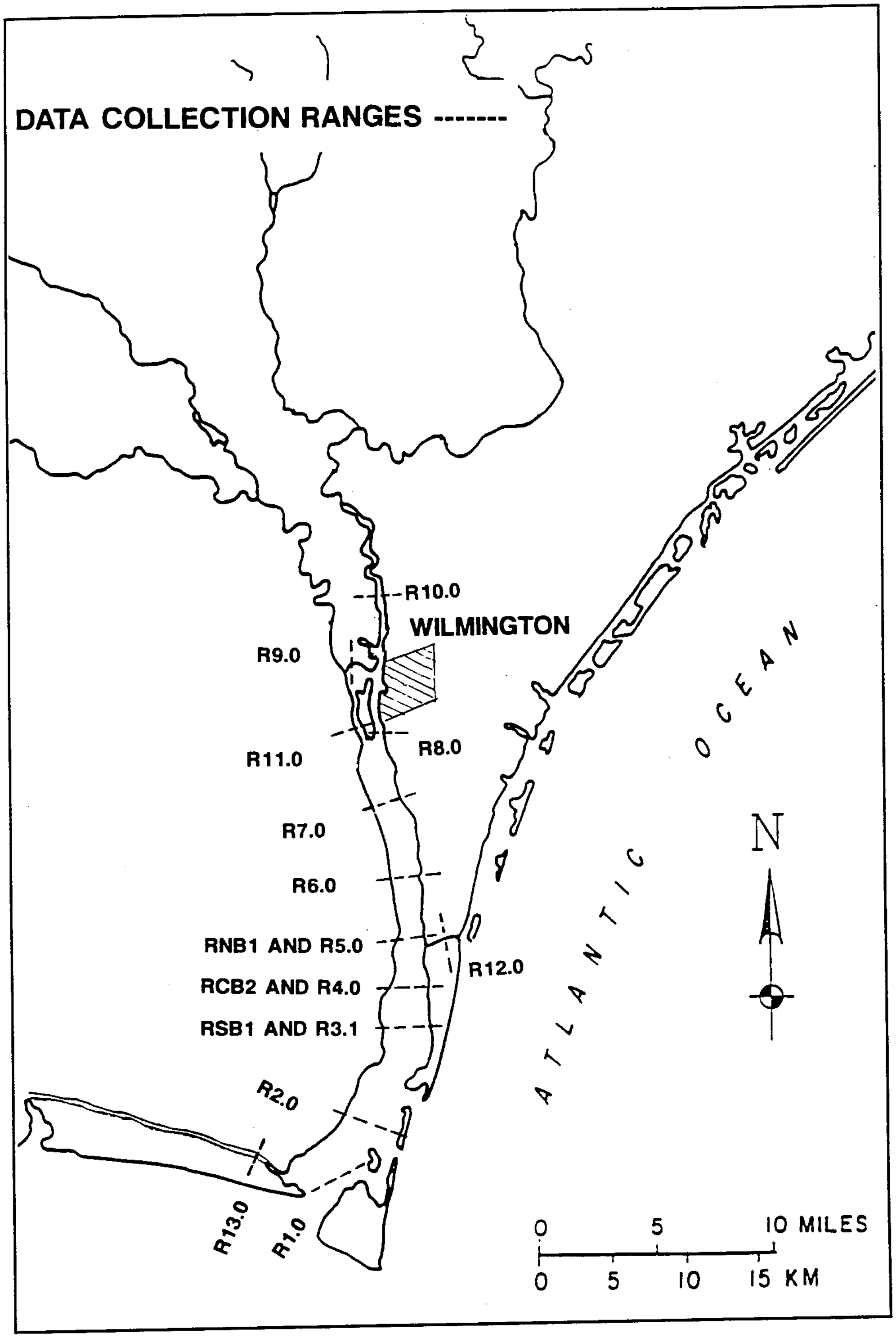


Figure 3. Data collection ranges

Intensive survey suspended sediment measurements

Suspended sediment concentrations were determined from the water samples collected during the short-term intensive surveys. Analysis of the

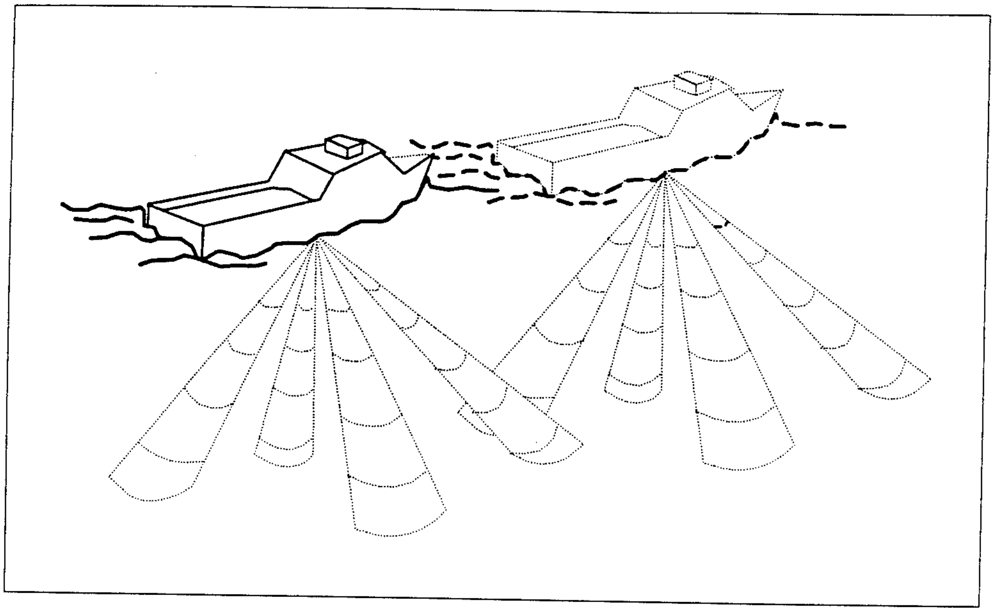


Figure 4. Acoustic Doppler Current Profiler beam configuration

samples for determining suspended sediment concentrations is described in Appendix A.

Procedures

Long-term instrumentation

A WES crew, with assistance from the Cape Fear Community College (CFCC), Wilmington, deployed the 16 current meters and 13 water level recorders from August 12-16, 1993, using the WES survey boat *Mr. Dave* and the CFCC boat R/V *Dan Moore*. Sites for the data collection stations and ranges were selected to coincide with monitoring stations used in previous studies. Visual inspection of the area and verification of channel depths determined the final instrument deployments. Every effort was made to satisfy the modelers' requested locations while ensuring the safety of the equipment.

Intensive surveys

For the two 13-hr data collection periods, 16 ranges were selected to provide maximum coverage of the study area and meet the needs of the modeling efforts. The locations of these ranges are shown in Figure 3 and described previously. Four boats (three WES and one CFCC) were outfitted with direct reading ADCP units and sampling apparatus. Cross-sectional transects were conducted with the ADCP at each range with water samples collected immediately after the transect at the sampling locations. On the first day, the four boats covered ranges R1.0, R2.0, R3.1, R4.0, R5.0, R6.0, R13.0,

RSB1, RCB2, and RNB1. On the second day, the four boats covered ranges R6.0, R7.0, R8.0, R9.0, R10.0, R11.0, and R12.0. Range R6.0 served as the swing range for the data collection at which data were collected on both days. At the beginning of the survey, the boats moved into position at their assigned ranges. Each boat traversed across its range making a continuous acoustic transect. The boat then travelled to the assigned sampling stations across the range and collected discrete water samples. The boat then travelled to its next assigned range and continued the procedure. When all the assigned ranges were monitored and sampled, the boat returned to the starting range and repeated the procedure. Data collection was originally scheduled to be on an hourly basis over a 13-hr tidal cycle. Excessive travel time between ranges made this impossible; therefore, data were collected at intervals in excess of an hour at some locations. Water samples were collected at three depths: near-bottom, middepth, and near-surface. Near-bottom samples were obtained at 2 ft above the actual bottom. Middepth samples were obtained at actual middepth levels. Near-surface samples were obtained at 3 ft below the water surface. Additional salinity measurements were made while collecting the water samples using a Hydrolab or Aanderaa salinity meter (Appendix A).

Long-term equipment problems

Some data loss is unavoidable in long-term data collection. Tables 1 and 2 present a deployment time-history of all the equipment locations during the study period. One of the major problems is destruction of submerged moored current meters and water level recorders by commercial fishing nets, local fishermen, barge and ship traffic, and vandalism. The Cape Fear River and the AIWW are very high traffic areas. The deployment locations were reported to the U.S. Coast Guard, and published in the Local Notice to Mariners. Local interest groups were also informed of the presence of equipment in the area; however, a few current meters were lost despite these precautions.

As with all long-term deployments, unattended equipment can become susceptible to bio-fouling and other mechanical problems. Suspended sediment content in the entire water column was very high; therefore, the abrasive sediment had the potential to quickly damage meter bearings. Some recorders and meters experienced mechanical problems and are noted in Tables 1 and 2.

Water level recorders at stations S1.3 and S6.0 malfunctioned; however, both stations had a redundant recorder so no data were lost at those locations. The water level recorder at station S3.0 recorded data for about 3 weeks before it malfunctioned. Both current meters at station S2.9 were lost and believed to be destroyed. A large cargo ship knocked out the meter string and Coast Guard buoy protecting it. Subsequent dragging operations found nothing. The current meter at station S8.9 malfunctioned after collecting three readings and the current meter at station S10.9 was never found.

Intensive survey equipment problems

A few problems were encountered during the short-term intensive surveys. The ADCP to be used on range R2.0 malfunctioned and would not operate. A backup current meter was not available at the time so current speed and direction were not collected for R2.0. A backup current meter was obtained for the second day of data collection. Other minor problems were a torn profiling cable (caught in a crab pot) and a broken water line on a boat motor. Some loss of data resulted while repairs were being made.

Conditions of the survey

The two 13-hr data collection surveys encompassed entire tide cycles during maximum tidal ranges (spring tide conditions). Excellent weather conditions prevailed during the surveys. Both days were sunny, with temperatures from 74 °F to 94 °F, and light northeast winds. The favorable weather conditions were conducive to gathering high-quality data.

3 Data Presentation

The data described here are presented in several different formats. Due to the magnitude of data collected for the Cape Fear River study, most of the data are shown in plots and representative samples of tabulated computer printouts. The data, collected from mid-August 1993 to mid-October 1993, are stored on floppy disks at WES and at the Wilmington District. The reader may obtain more detailed information upon written request to the following address:

U.S. Army Engineer Waterways Experiment Station
ATTN: CEWES-HP-P
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

Long-term Water Level Recorder Measurements

Table 1 shows the list of available water level recorder data collected for each station during the data collection program. A beginning and ending date for each data record is shown along with some comments regarding the station. Tables 3 and 4 are sample printouts of water level data collected at 15-min sampling for stations S1.3 and S6.0, respectively. The data on the sample printouts were recorded on 08/16/93 for station S1.3 and 08/15/93 for station S6.0. These two sample printouts were chosen at random and begin at the time the water level recorders were deployed. The printouts list the station location, date, time (EST), water temperature, conductivity, salinity, and depth (depth of sensor below water surface).

Time-history plots of the water surface data are presented in Plates 1-21. All the plots are from the time of deployment through the duration of the station and are split into two time frames, 08/12/93-09/16/93 and 09/16/93-10/18/93. Each plot shows the water surface elevation, salinity, and the water temperature. Datum planes for the gages are arbitrary. The datum for each water surface elevation plot represents the mean water level reading for each location.

The plots for station S3.0, Plate 5, show the data from the time of deployment until the recorder malfunctioned. Stations S9.0, S10.0, and S11.0, Plates 16-21, were deployed in mostly freshwater areas of the Northeast Cape Fear River, the Black River, and the Cape Fear River, respectively, and indicate little or no salinity.

Long-term Current Meter Measurements

Table 2 presents a list of available current meter data collected at each station during the data collection program. A beginning and ending date for each data record is shown along with some comments regarding the station. Tables 5 and 6 are sample printouts of current meter data collected at 15-min sampling intervals for stations S1.2A and S5.9A, respectively. The data on the sample printouts were recorded on 08/13/93 for station S1.2A and 08/12/93 for station S5.9A. These two sample printouts were chosen at random and begin at the time the current meters were deployed. The printouts list the station location, date, time (EST), current speed, current direction, water temperature, conductivity, and salinity. Both meters were deployed at middepth at their respective locations.

Time-history plots of the current meter data are presented in Plates 22-45. All the plots are from the time of deployment through the duration of the station and are split into two time frames, 08/12/93-09/16/93, and 09/16/93-10/18/93. Each plot shows the current speed, salinity, and the water temperature.

Intensive Survey Current Measurements

Current speed data collected with the ADCP are presented in Plates 46-117. Current speed data collected with a profiling over-the-side meter are presented in Plates 118 and 119 for ranges R9.0 and R10.0, respectively. About 200 acoustic transects were collected with the ADCP over the 2-day intensive survey. The data were processed into files to extract the current speed for a known depth at a particular time and then plotted in a time-series format. Several distances across each data collection range were then selected for presentation. Depending on the depth of water at the range location, data were selected for either three depths, near-surface, middepth, and near-bottom, or five depths, near-surface, one-quarter depth, middepth, three-quarter depth, and near-bottom. Channel center-line current speed data at near-surface, middepth, and near-bottom for ranges R9.0 and R10.0 are shown in Plates 118 and 119.

Intensive survey salinity measurements

Salinity concentrations are presented in Plates 120-142. Water samples for salinity measurements were collected following each ADCP transect at each range. The samples were collected at three depths, near-surface, middepth, and near-bottom, and at either center-line or quarter points in the channel. Stations on ranges R1.0, R2.0, R5.0, R6.0, and R8.0 were collected at the quarter points and are noted as A or C. The remaining stations were center line and are noted as B.

Water samples were collected at the time of deployment of the water level recorders, and the data are presented in Table 7. The station number, time, date, depth of sample, salinity, and suspended sediment concentration are listed in the table. Several salinity profiles in the center line of the channel were measured at the start and ending of the project. These measurements are listed in Tables 8 and 9, respectively.

Intensive Survey Suspended Sediment Concentrations

Suspended sediment concentrations were measured from the water samples collected during the short-term intensive surveys, and the data are presented in Plates 143-165. The suspended sediment concentrations are shown in mg/l and were collected at three depths, near-surface, middepth, and near-bottom.

4 Summary

The data collected as described herein provided essential information to establish the geometry, boundary conditions, and verification data needed for the numerical modeling prediction efforts. This study will assist the Wilmington District in formulating the project design and assessing impacts due to project construction.

Table 3
Sample Printout of Water Level Recorder Data for Station S1.3

CAPE FEAR RIVER
STATION S1.3 FT. CASWELL
ENDECO TYPE 1152 DENSITY COMPENSATING WATER LEVEL RECORDER
INITIAL DEPTH: 1.566(METERS) AT 08/16/93 13:15
DATUM OFFSET APPLIED: .000(METERS)
SERIAL NUMBER: 11520683

DATE (MM/DD/YY)	TIME (HH:MM)	TEMPERATURE (CELSIUS)	CONDUCTIVITY (MMHO/CM)	SALINITY (PPT)	DEPTH (METERS)[1]
08/16/93	13:15	28.93	46.65	27.8	1.566
08/16/93	13:30	28.14	46.18	28.0	1.656
08/16/93	13:45	27.76	45.94	28.1	1.753
08/16/93	14:00	27.60	45.81	28.1	1.836
08/16/93	14:15	27.57	46.25	28.4	1.951
08/16/93	14:30	27.60	47.25	29.0	2.073
08/16/93	14:45	27.65	47.61	29.3	2.182
08/16/93	15:00	27.60	48.18	29.7	2.283
08/16/93	15:15	27.60	48.37	29.8	2.388
08/16/93	15:30	27.59	49.32	30.5	2.494
08/16/93	15:45	27.56	51.88	32.3	2.566
08/16/93	16:00	27.47	52.72	32.9	2.650
08/16/93	16:15	27.40	52.81	33.0	2.722
08/16/93	16:30	27.37	53.71	33.7	2.801
08/16/93	16:45	27.38	53.67	33.7	2.878
08/16/93	17:00	27.38	52.96	33.2	2.944
08/16/93	17:15	27.42	54.15	34.0	3.003
08/16/93	17:30	27.40	54.22	34.0	3.045
08/16/93	17:45	27.39	54.23	34.1	3.085
08/16/93	18:00	27.36	54.29	34.1	3.104
08/16/93	18:15	27.36	53.95	33.9	3.127
08/16/93	18:30	27.36	54.55	34.3	3.138
08/16/93	18:45	27.33	54.31	34.1	3.135
08/16/93	19:00	27.34	54.19	34.1	3.123
08/16/93	19:15	27.33	54.44	34.2	3.095
08/16/93	19:30	27.31	54.42	34.2	3.059
08/16/93	19:45	27.29	54.62	34.4	2.993
08/16/93	20:00	27.27	54.09	34.0	2.921
08/16/93	20:15	27.28	54.22	34.1	2.815
08/16/93	20:30	27.29	54.09	34.0	2.721
08/16/93	20:45	27.31	53.61	33.7	2.614
08/16/93	21:00	27.30	52.92	33.2	2.522
08/16/93	21:15	27.29	53.44	33.6	2.412
08/16/93	21:30	27.33	52.26	32.7	2.298
08/16/93	21:45	27.36	52.79	33.1	2.179
08/16/93	22:00	27.40	51.46	32.1	2.086
08/16/93	22:15	27.43	51.32	32.0	1.982
08/16/93	22:30	27.45	50.26	31.2	1.908
08/16/93	22:45	27.47	49.53	30.7	1.841
08/16/93	23:00	27.49	50.05	31.1	1.759

[1]Datum is arbitrary.

Table 4
Sample Printout of Water Level Recorder Data for Station S6.0

CAPE FEAR RIVER
STATION S6.0 CHANNEL MARKER 53 NEAR EXXON PIER
ENDECO TYPE 1152 DENSITY COMPENSATING WATER LEVEL RECORDER
INITIAL DEPTH: 1.674 (METERS) AT 08/15/93 16:45 EST
DATUM OFFSET APPLIED: .000 (METERS)
SERIAL NUMBER: 11520596

DATE (MM/DD/YY)	TIME (HH:MM)	TEMPERATURE (CELSIUS)	CONDUCTIVITY (MMHO/CM)	SALINITY (PPT)	DEPTH (METERS)[1]
08/15/93	16:45	28.55	21.25	11.8	1.674
08/15/93	17:00	28.16	22.33	12.6	1.752
08/15/93	17:15	27.99	22.36	12.6	1.809
08/15/93	17:30	27.97	23.95	13.6	1.877
08/15/93	17:45	27.88	24.57	14.0	1.931
08/15/93	18:00	27.84	25.34	14.5	1.976
08/15/93	18:15	27.81	23.84	13.6	2.024
08/15/93	18:30	27.82	26.15	15.0	2.062
08/15/93	18:45	27.80	23.02	13.1	2.102
08/15/93	19:00	27.82	27.02	15.6	2.118
08/15/93	19:15	27.79	23.41	13.3	2.140
08/15/93	19:30	27.84	25.91	14.9	2.147
08/15/93	19:45	27.86	24.07	13.7	2.155
08/15/93	20:00	27.88	24.55	14.0	2.145
08/15/93	20:15	27.86	25.94	14.9	2.114
08/15/93	20:30	27.82	25.62	14.7	2.075
08/15/93	20:45	27.81	26.06	15.0	2.015
08/15/93	21:00	27.81	25.75	14.8	1.946
08/15/93	21:15	27.81	24.91	14.3	1.873
08/15/93	21:30	27.82	24.30	13.9	1.806
08/15/93	21:45	27.83	25.74	14.8	1.736
08/15/93	22:00	27.79	25.11	14.4	1.664
08/15/93	22:15	27.77	23.39	13.3	1.599
08/15/93	22:30	27.77	23.47	13.4	1.533
08/15/93	22:45	27.77	22.87	13.0	1.470
08/15/93	23:00	27.77	22.68	12.9	1.405
08/15/93	23:15	27.77	22.59	12.8	1.348
08/15/93	23:30	27.77	22.00	12.5	1.285
08/15/93	23:45	27.77	21.68	12.3	1.237
08/16/93	00:00	27.79	21.80	12.3	1.184
08/16/93	00:15	27.79	21.75	12.3	1.128
08/16/93	00:30	27.80	21.02	11.8	1.074
08/16/93	00:45	27.80	20.85	11.7	1.022
08/16/93	01:00	27.79	20.71	11.7	0.972
08/16/93	01:15	27.77	20.36	11.5	0.918
08/16/93	01:30	27.74	20.06	11.3	0.871
08/16/93	01:45	27.72	19.83	11.1	0.832
08/16/93	02:00	27.70	19.34	10.8	0.798
08/16/93	02:15	27.68	19.15	10.7	0.774
08/16/93	02:30	27.67	18.51	10.3	0.763

[1]Datum is arbitrary.

Table 5
Sample Printout of Current Meter Data for Station S1.2A

CAPE FEAR RIVER
STATION S1.2A CHANNEL NEAR FT. CASWELL
ENDECO Type 174SSM Solid State Current Meter
Serial Number: 174SSM0307
Date: FRI 13-AUG-1993 Julian date: 225 Magnetic Variation: -8.0

TIME (EST)	SPEED (CM/SC)	DIR (TRU)[1]	TEMP (C)	COND (MS/CM)	SALN (PPT)
08:30:00	82.39	132	27.36	48.03	29.74
08:45:00	78.36	131	27.36	47.88	29.63
09:00:00	74.85	132	27.36	47.72	29.52
09:15:00	66.81	132	27.36	47.40	29.30
09:30:00	64.80	134	27.36	47.25	29.19
09:45:00	57.27	132	27.36	47.09	29.08
10:00:00	44.21	132	27.36	46.93	28.98
10:15:00	34.66	134	27.36	46.78	28.87
10:30:00	22.10	134	27.36	46.78	28.87
10:45:00	11.05	115	27.36	46.78	28.87
11:00:00	5.53	322	27.36	47.25	29.19
11:15:00	26.12	298	27.27	47.40	29.36
11:30:00	42.70	305	27.27	47.56	29.47
11:45:00	48.22	314	27.27	47.40	29.36
12:00:00	48.73	318	27.27	47.56	29.47
12:15:00	43.70	318	27.27	47.88	29.69
12:30:00	49.73	316	27.27	48.03	29.80
12:45:00	56.26	318	27.07	49.13	30.69
13:00:00	52.75	321	27.07	50.39	31.57
13:15:00	57.77	316	27.07	52.12	32.78
13:30:00	57.27	311	26.97	52.43	33.08
13:45:00	69.83	311	26.97	52.90	33.41
14:00:00	75.35	308	26.88	53.37	33.82
14:15:00	63.80	308	26.88	53.53	33.93
14:30:00	13.06	308	26.78	53.69	34.11
14:45:00	64.80	309	26.88	53.69	34.04
15:00:00	39.18	305	26.78	54.00	34.33
15:15:00	.00	321	26.78	54.16	34.45
15:30:00	.00	312	26.78	54.16	34.45
15:45:00	.00	312	26.78	54.16	34.45
16:00:00	10.55	311	26.78	54.47	34.67
16:15:00	44.71	308	26.78	54.31	34.56
16:30:00	40.69	309	26.88	54.31	34.49
16:45:00	27.63	314	26.88	54.47	34.60
17:00:00	9.04	322	26.78	54.16	34.45
17:15:00	2.01	79	26.78	54.31	34.56
17:30:00	6.03	121	26.97	54.16	34.30
17:45:00	13.06	143	26.97	54.00	34.19
18:00:00	18.09	118	27.17	53.84	33.94
18:15:00	21.60	112	27.27	53.69	33.75
18:30:00	52.75	141	27.07	52.74	33.23

[1]Direction from true north from which the current is flowing.

Table 6
Sample Printout of Current Meter Data for Station S5.9A

CAPE FEAR RIVER
STATION S5.9A CHANNEL NEAR EXXON PIER
ENDECO Type 174SSM Solid State Current Meter
Serial Number: 174SSM0298
Date: THU 12-AUG-1993 Julian date: 224 Magnetic Variation: -8.0

TIME (EST)	SPEED (CM/SC)	DIR (TRU)[1]	TEMP (C)	COND (MS/CM)	SALN (PPT)
09:30:00	47.22	176	27.92	28.34	16.39
09:45:00	36.17	172	27.92	28.34	16.39
10:00:00	43.20	179	28.01	27.25	15.67
10:15:00	38.68	172	27.92	26.00	14.91
10:30:00	34.16	174	27.92	26.31	15.11
10:45:00	29.14	163	28.01	27.09	15.57
11:00:00	25.12	167	28.01	23.82	13.52
11:15:00	15.57	152	27.92	23.66	13.45
11:30:00	12.56	179	27.92	22.72	12.87
11:45:00	6.53	335	28.01	24.91	14.20
12:00:00	12.56	335	28.01	23.35	13.23
12:15:00	16.58	336	28.01	23.04	13.04
12:30:00	23.61	349	27.92	23.04	13.06
12:45:00	30.14	0	28.01	23.04	13.04
13:00:00	41.19	1	28.01	23.04	13.04
13:15:00	49.23	0	27.92	23.97	13.64
13:30:00	63.30	1	28.01	25.06	14.30
13:45:00	65.80	356	27.92	24.60	14.03
14:00:00	64.80	3	28.01	24.28	13.81
14:15:00	58.27	6	27.82	28.50	16.52
14:30:00	62.29	8	27.92	26.31	15.11
14:45:00	67.31	359	27.92	27.56	15.90
15:00:00	58.78	8	27.62	31.93	18.80
15:15:00	60.28	8	27.92	28.50	16.49
15:30:00	57.27	10	27.72	29.28	17.06
15:45:00	50.23	7	27.72	31.77	18.66
16:00:00	49.73	4	27.62	32.86	19.41
16:15:00	50.74	4	27.82	31.62	18.52
16:30:00	39.69	8	28.21	28.34	16.29
16:45:00	44.21	6	27.62	33.65	19.92
17:00:00	41.19	7	27.62	33.80	20.02
17:15:00	31.14	14	27.72	32.55	19.17
17:30:00	12.56	32	27.82	31.62	18.52
17:45:00	9.04	353	27.82	31.77	18.62
18:00:00	13.56	353	27.82	32.24	18.93
18:15:00	10.55	90	27.72	32.86	19.37
18:30:00	8.54	125	27.62	33.33	19.72
18:45:00	6.03	184	27.72	32.71	19.27
19:00:00	6.53	202	27.82	32.40	19.03
19:15:00	15.07	186	28.01	28.96	16.75

[1]Direction from true north from which the current is flowing.

Table 7
Water Samples Collected at Water Level Recorder Deployment

Station	Time (EST)	Date	Depth ft	Salinity ppt	Suspended Sediment mg/ℓ
S1.2	1230	8/16/93	3.0	29.2	18
S1.3	1303	8/16/93	4.0	28.8	20
S2.0	1208	8/16/93	4.7	28.2	31
S3.0	1044	8/16/93	4.1	23.7	49
S3.5	0848	8/16/93	5.0	22.9	18
S4.0	0955	8/16/93	4.3	20.1	5
S6.0	1600	8/15/93	3.0	9.6	13
S7.0	1135	8/15/93	2.0	3.0	33
S8.0	1500	8/15/93	3.0	6.8	18
S9.0	1048	8/17/93	2.0	0.0	11
S11.0	1140	8/17/93	3.0	0.0	5

Table 8
Salinity Profiles at Start of Data Collection

Station	Date	Time (EST)	Depth, ft	Salinity, ppt
S1.2	8/16/93	1228-1231	54	29.5
			50	29.5
			45	29.5
			40	29.5
			35	29.5
			30	29.5
			25	29.5
			20	29.5
			15	29.5
			10	29.5
			5	29.5
			2	29.5
S2.9	8/16/93	1053-1056	46	28.5
			40	28.5
			35	28.4
			30	28.3
			25	28.3
			20	27.6
			15	27.0
			10	25.7
			5	24.7
			2	14.6
S3.4	8/16/93	0904-0906	16	23.0
			12	23.0
			7	23.1
			2	22.9
S3.9	8/16/93	1014-1016	42	24.9
			40	25.0
			35	24.8
			30	24.4
			25	24.2
			20	24.1
			15	23.7
			10	22.9

(Continued)

Table 8 (Concluded)

Station	Date	Time (EST)	Depth, ft	Salinity, ppt
S3.9 (Continued)	8/16/93	1014-1016	5	20.6
			2	19.9
S4.0	8/16/93	0941-0943	18	23.9
			14	23.6
			10	21.8
			6	21.2
			2	20.2
S5.9	8/17/93	1338-1340	40	15.4
			35	15.0
			30	14.9
			25	13.6
			20	12.3
			15	11.3
			10	10.9
			5	10.7
			2	10.4
S6.9	8/17/93	1405-1408	45	4.2
			40	4.1
			35	4.4
			30	4.3
			25	4.2
			20	3.9
			15	3.7
			10	3.5
			5	3.3
			2	2.5
S7.9	8/17/93	1424-1426	32	9.7
			30	9.7
			25	9.7
			20	9.6
			15	9.5
			10	9.5
			5	9.5
			2	9.5

Table 9
Salinity Profiles at End of Data Collection

Station	Date	Time (EST)	Depth, ft	Salinity, ppt
S1.2	10/18/93	1420-1429	48	33.8
			45	33.8
			40	33.8
			35	33.8
			30	33.8
			25	33.8
			20	33.8
			15	33.8
			10	33.8
			5	33.8
S2.0	10/18/93	1455-1502	40	33.1
			35	33.1
			30	33.1
			25	33.1
			20	33.0
			15	33.0
			10	32.9
			5	32.4
S2.9	10/18/93	1523-1530	40	31.5
			35	31.6
			30	31.5
			25	31.4
			20	30.1
			15	29.7
			10	29.9
			5	29.1
S3.4	10/18/93	1318-1321	20	27.5
			15	27.5
			10	27.5
			5	27.4
S3.5	10/16/93	1550-1555	23	28.5
			20	28.4
			15	28.4

(Sheet 1 of 3))

Table 8 (Concluded)				
Station	**Date**	**Time (EST)**	**Depth, ft**	**Salinity, ppt**
S3.9 (Continued)	8/16/93	1014-1016	5	20.6
			2	19.9
S4.0	8/16/93	0941-0943	18	23.9
			14	23.6
			10	21.8
			6	21.2
			2	20.2
S5.9	8/17/93	1338-1340	40	15.4
			35	15.0
			30	14.9
			25	13.6
			20	12.3
			15	11.3
			10	10.9
			5	10.7
			2	10.4
S6.9	8/17/93	1405-1408	45	4.2
			40	4.1
			35	4.4
			30	4.3
			25	4.2
			20	3.9
			15	3.7
			10	3.5
			5	3.3
			2	2.5
S7.9	8/17/93	1424-1426	32	9.7
			30	9.7
			25	9.7
			20	9.6
			15	9.5
			10	9.5
			5	9.5
			2	9.5

Table 9
Salinity Profiles at End of Data Collection

Station	Date	Time (EST)	Depth, ft	Salinity, ppt
S1.2	10/18/93	1420-1429	48	33.8
			45	33.8
			40	33.8
			35	33.8
			30	33.8
			25	33.8
			20	33.8
			15	33.8
			10	33.8
			5	33.8
S2.0	10/18/93	1455-1502	40	33.1
			35	33.1
			30	33.1
			25	33.1
			20	33.0
			15	33.0
			10	32.9
			5	32.4
S2.9	10/18/93	1523-1530	40	31.5
			35	31.6
			30	31.5
			25	31.4
			20	30.1
			15	29.7
			10	29.9
			5	29.1
S3.4	10/18/93	1318-1321	20	27.5
			15	27.5
			10	27.5
			5	27.4
S3.5	10/16/93	1550-1555	23	28.5
			20	28.4
			15	28.4

(Sheet 1 of 3))

Table 9 (Continued)

Station	Date	Time (EST)	Depth, ft	Salinity, ppt
S3.5 (Continued)	10/16/93	1550-1555	10	28.4
			5	28.3
S3.9	10/16/93	1500-1506	40	25.6
			35	25.5
			30	25.1
			25	24.9
			20	24.8
			15	24.5
			10	23.4
			5	23.3
S5.9	10/16/93	1410-1418	46	24.0
			40	24.0
			35	23.2
			30	21.9
			25	20.9
			20	19.7
			15	19.4
			10	18.2
			5	17.8
S6.9	10/16/93	1201-1208	38	15.7
			35	15.7
			30	15.7
			25	15.6
			20	15.5
			15	14.8
			10	13.6
			5	13.4
S7.9	10/16/93	1255-1300	42	16.3
			40	16.3
			35	16.3
			30	16.0
			25	16.0
			20	15.8
			15	15.5

Table 9 (Concluded)

Station	Date	Time (EST)	Depth, ft	Salinity, ppt
S.7.9 (Continued)	10/16/93	1255-1300	10	15.4
			5	15.4
S8.9	10/17/93	1012-1019	46	00.1
			40	00.1
			35	00.1
			30	00.1
			25	00.1
			20	00.1
			15	00.1
			10	00.1
			5	00.1
S9.9	10/17/93	1217-1218	7	00.1
			5	00.1
			2	00.1
S10.9	10/17/93	1653-1656	29	00.1
			20	00.1
			15	00.1
			10	00.1
			5	00.1

(Sheet 3 of 3)

Table 9 (Continued)

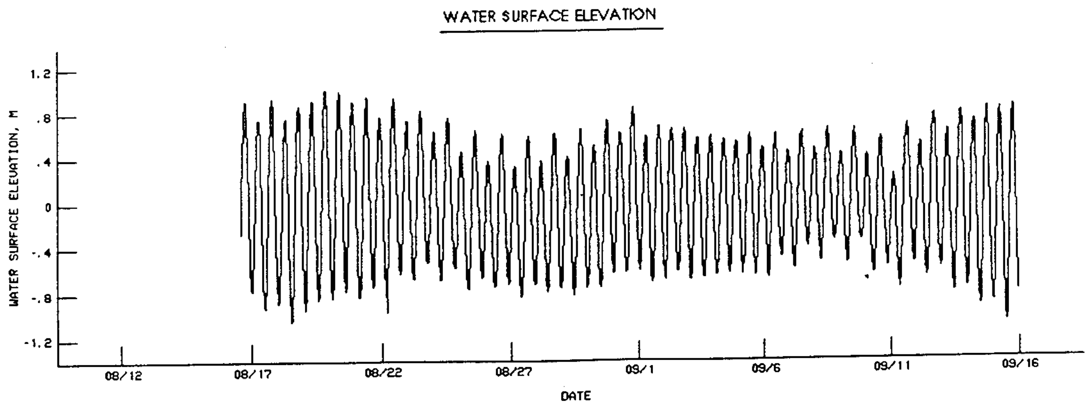
Station	Date	Time (EST)	Depth, ft	Salinity, ppt
S3.5 (Continued)	10/16/93	1550-1555	10	28.4
			5	28.3
S3.9	10/16/93	1500-1506	40	25.6
			35	25.5
			30	25.1
			25	24.9
			20	24.8
			15	24.5
			10	23.4
			5	23.3
S5.9	10/16/93	1410-1418	46	24.0
			40	24.0
			35	23.2
			30	21.9
			25	20.9
			20	19.7
			15	19.4
			10	18.2
			5	17.8
S6.9	10/16/93	1201-1208	38	15.7
			35	15.7
			30	15.7
			25	15.6
			20	15.5
			15	14.8
			10	13.6
			5	13.4
S7.9	10/16/93	1255-1300	42	16.3
			40	16.3
			35	16.3
			30	16.0
			25	16.0
			20	15.8
			15	15.5

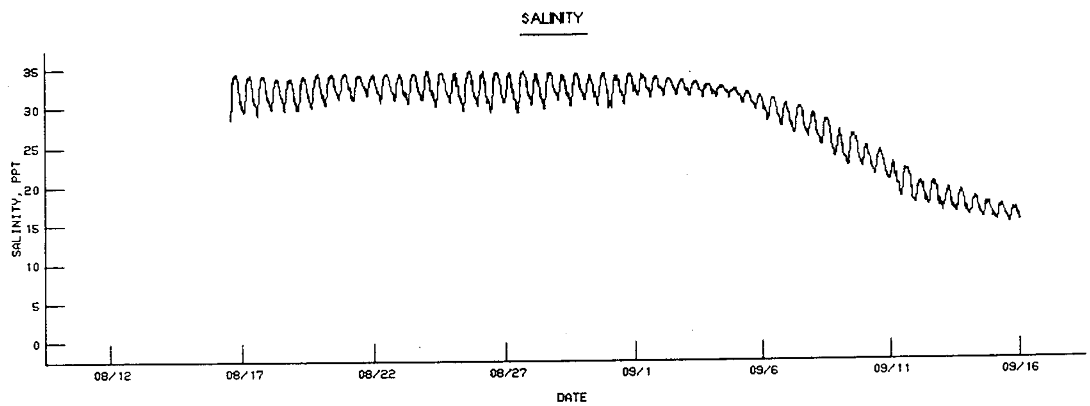
(Sheet 2 of 3)

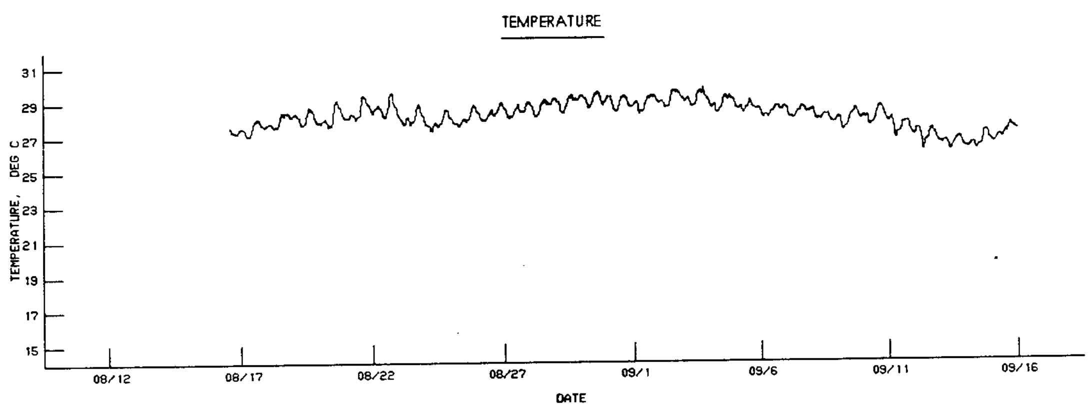
Table 9 (Concluded)

Station	Date	Time (EST)	Depth, ft	Salinity, ppt
S.7.9 (Continued)	10/16/93	1255-1300	10	15.4
			5	15.4
S8.9	10/17/93	1012-1019	46	00.1
			40	00.1
			35	00.1
			30	00.1
			25	00.1
			20	00.1
			15	00.1
			10	00.1
			5	00.1
S9.9	10/17/93	1217-1218	7	00.1
			5	00.1
			2	00.1
S10.9	10/17/93	1653-1656	29	00.1
			20	00.1
			15	00.1
			10	00.1
			5	00.1

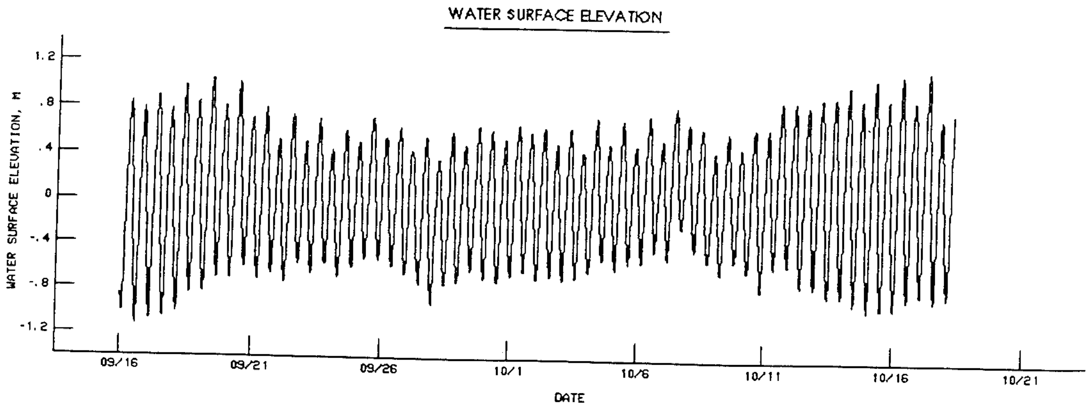
(Sheet 3 of 3)

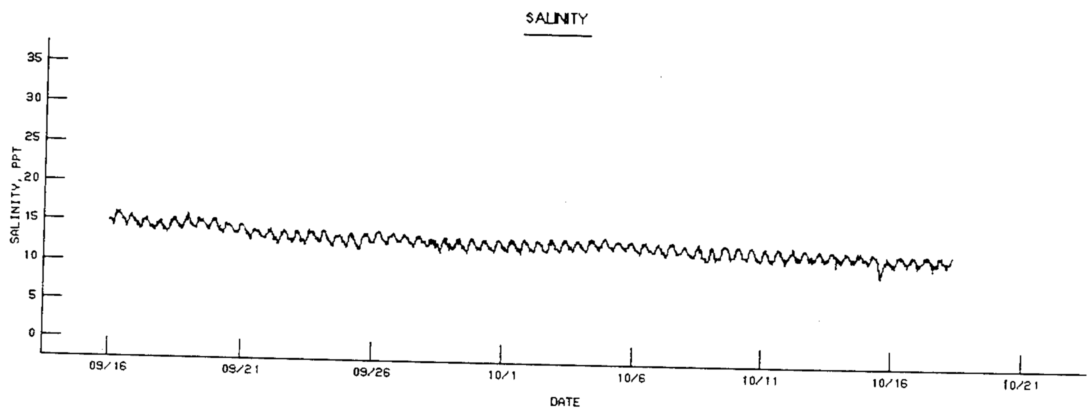


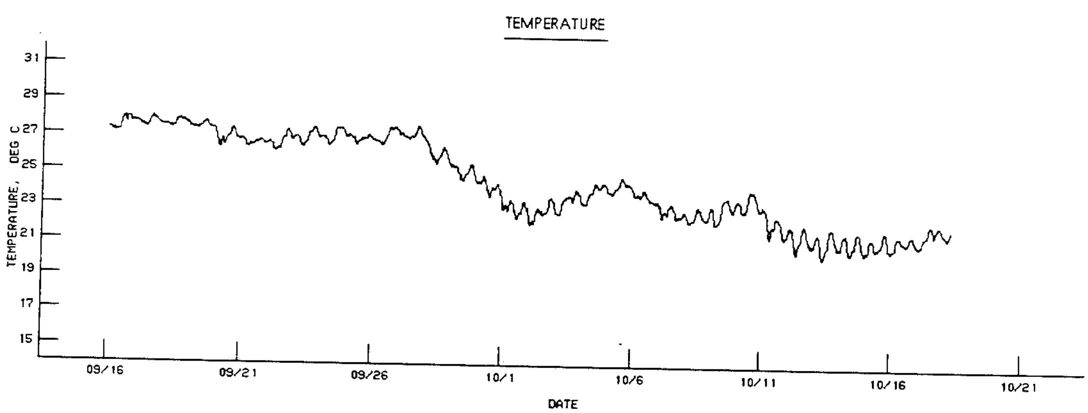




WATER SURFACE ELEVATION,
SALINITY, AND TEMPERATURE
STATION S1.3
08/12/93 - 09/16/93

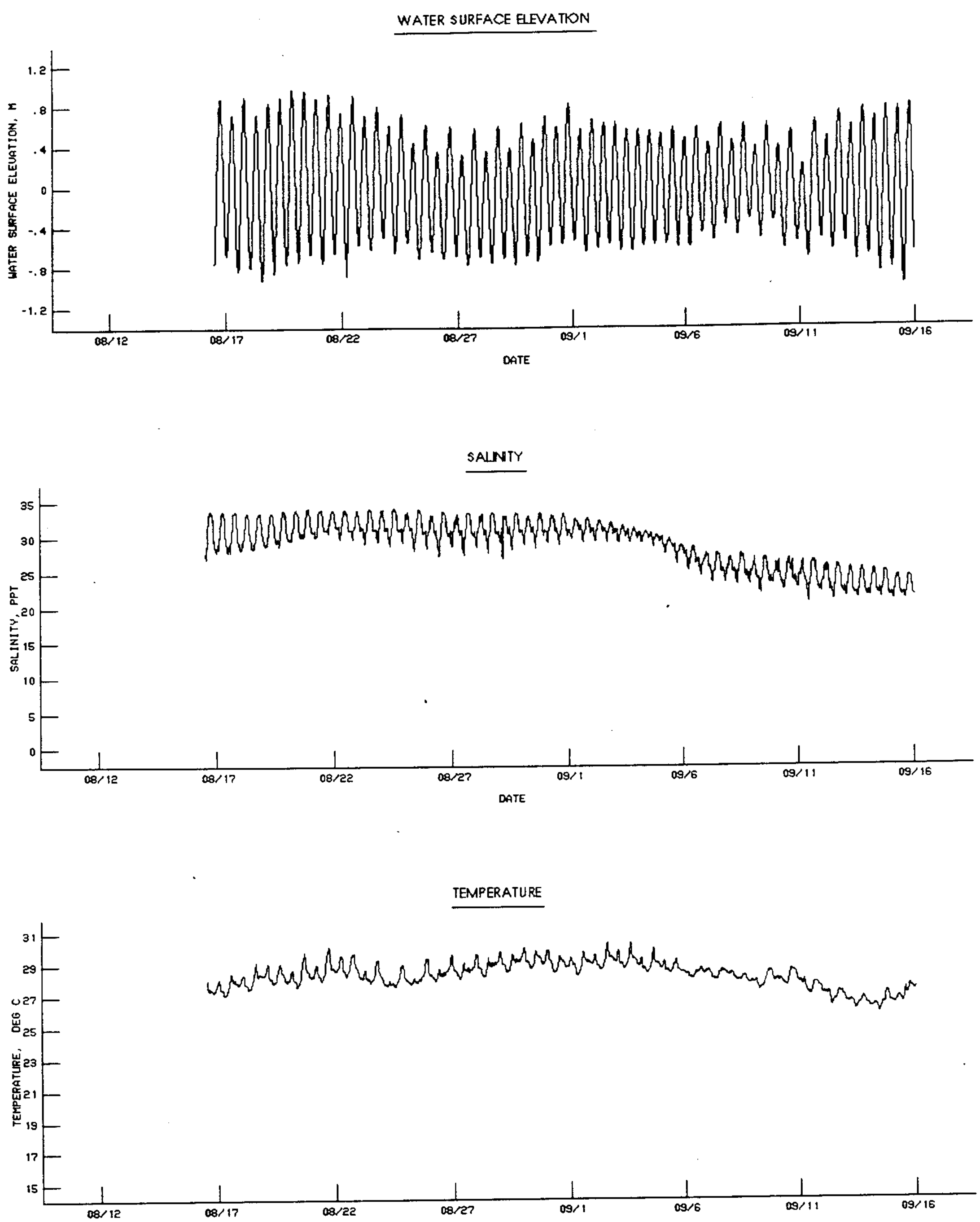




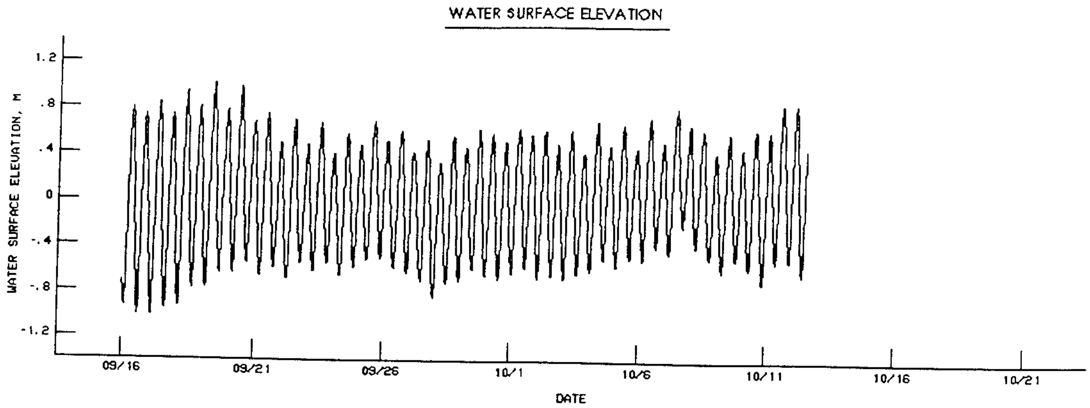


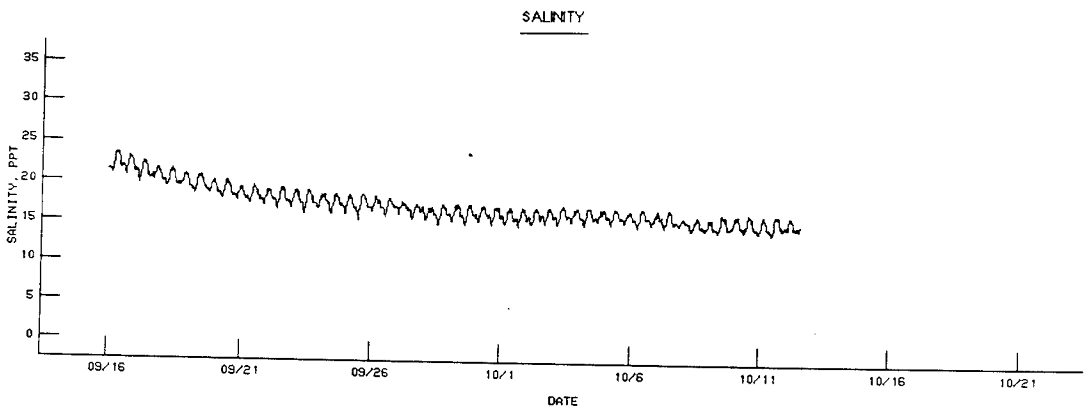
WATER SURFACE ELEVATION,
SALINITY, AND TEMPERATURE
STATION S1.3
09/16/93 - 10/18/93

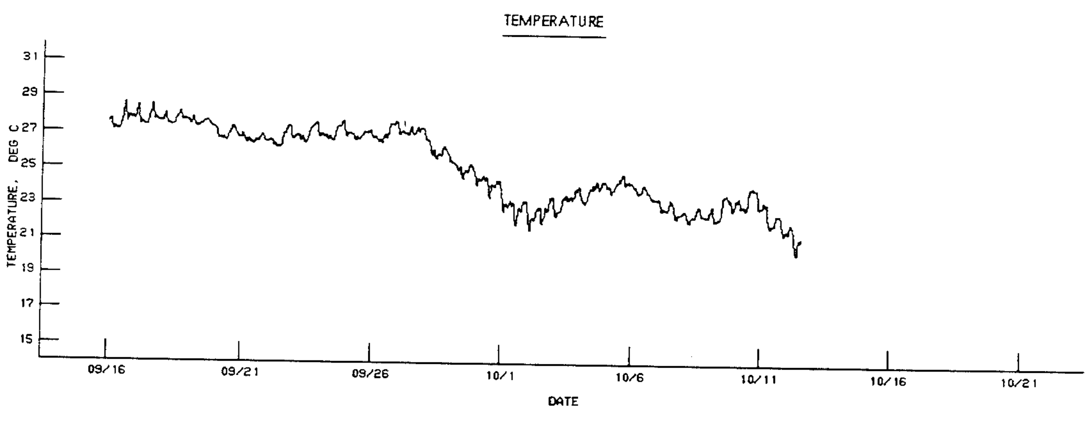
Plate 2



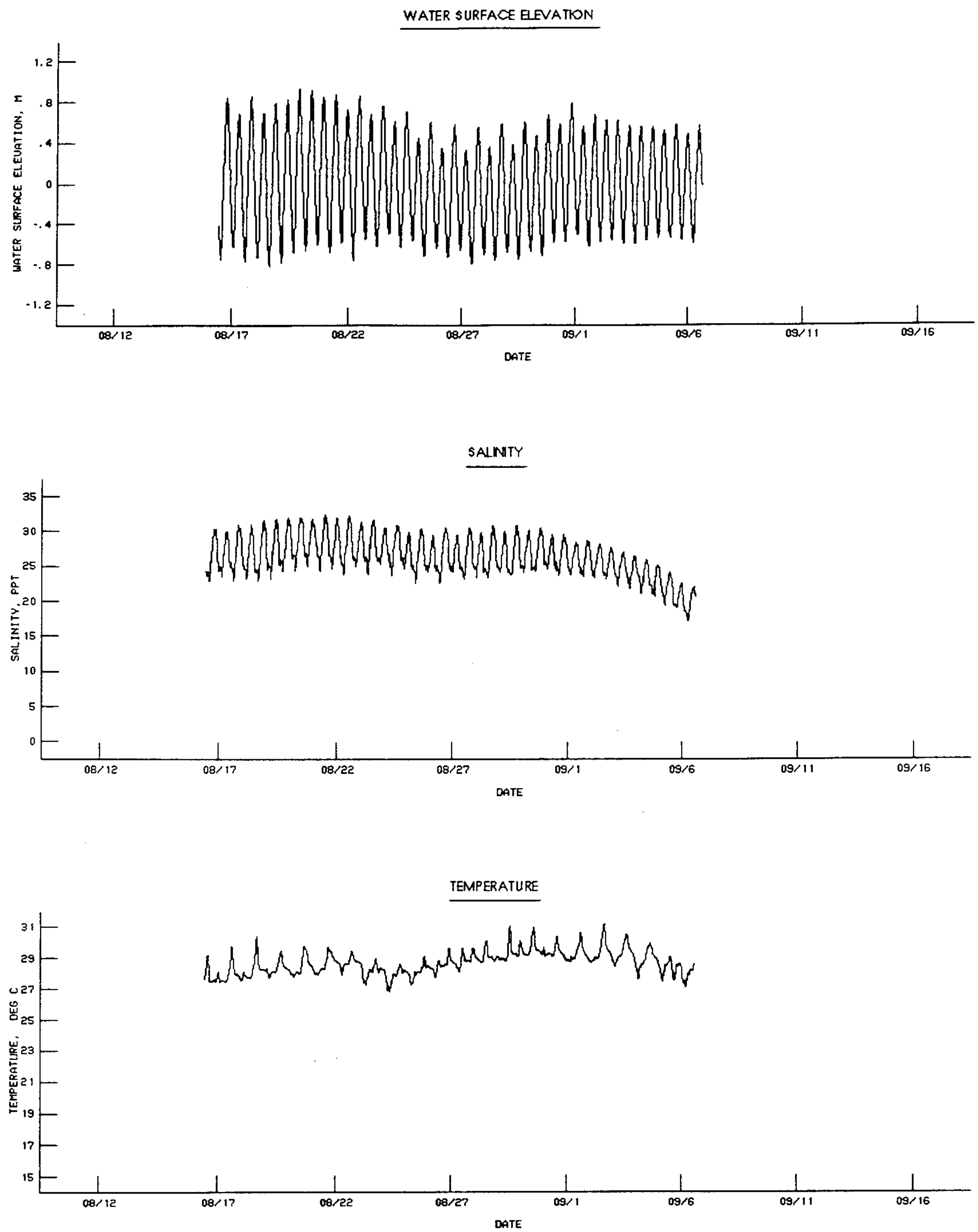
WATER SURFACE ELEVATION,
SALINITY, AND TEMPERATURE
STATION S2.0
08/12/93 - 09/16/93



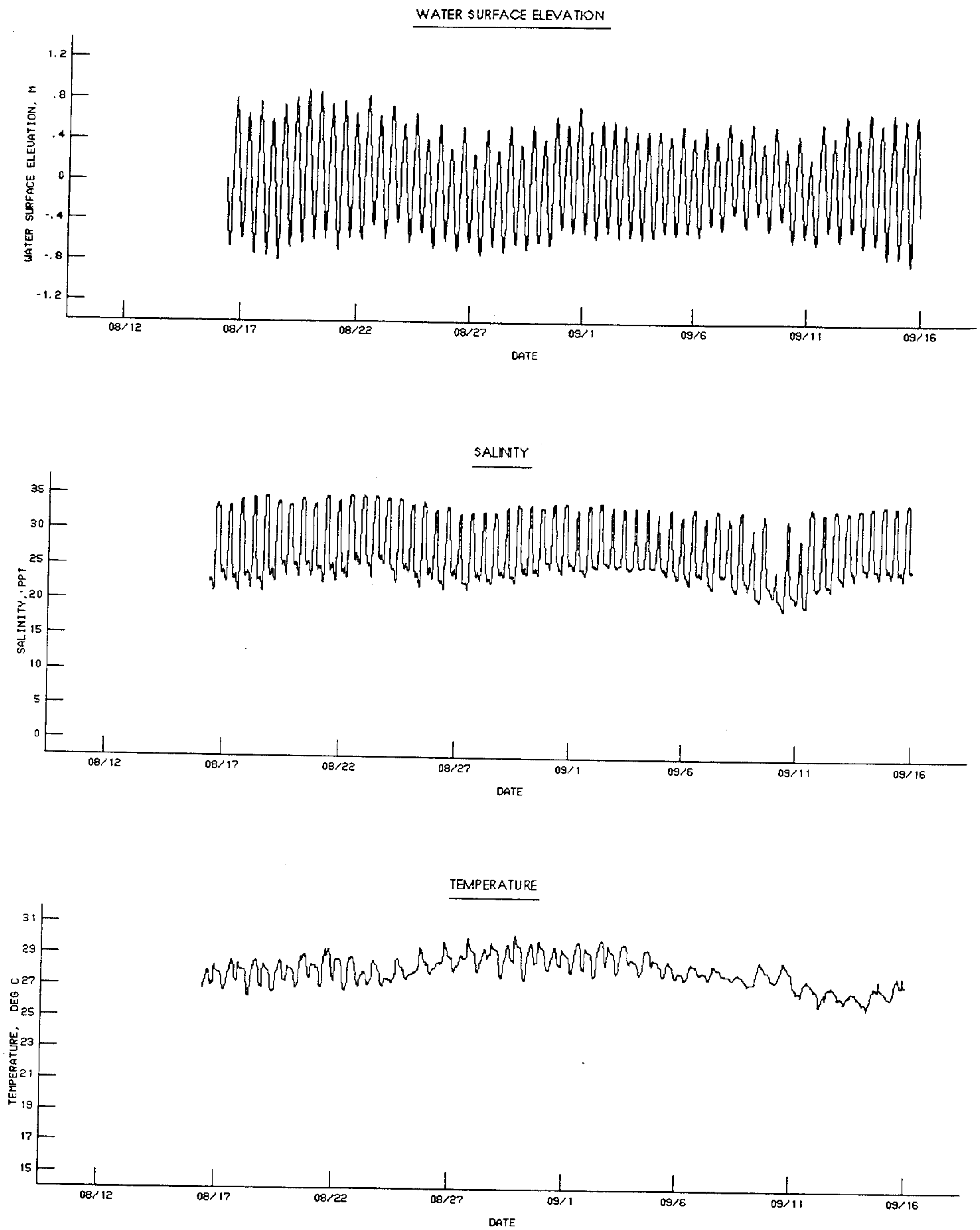




WATER SURFACE ELEVATION,
SALINITY, AND TEMPERATURE
STATION S2.0
09/16/93 - 10/18/93

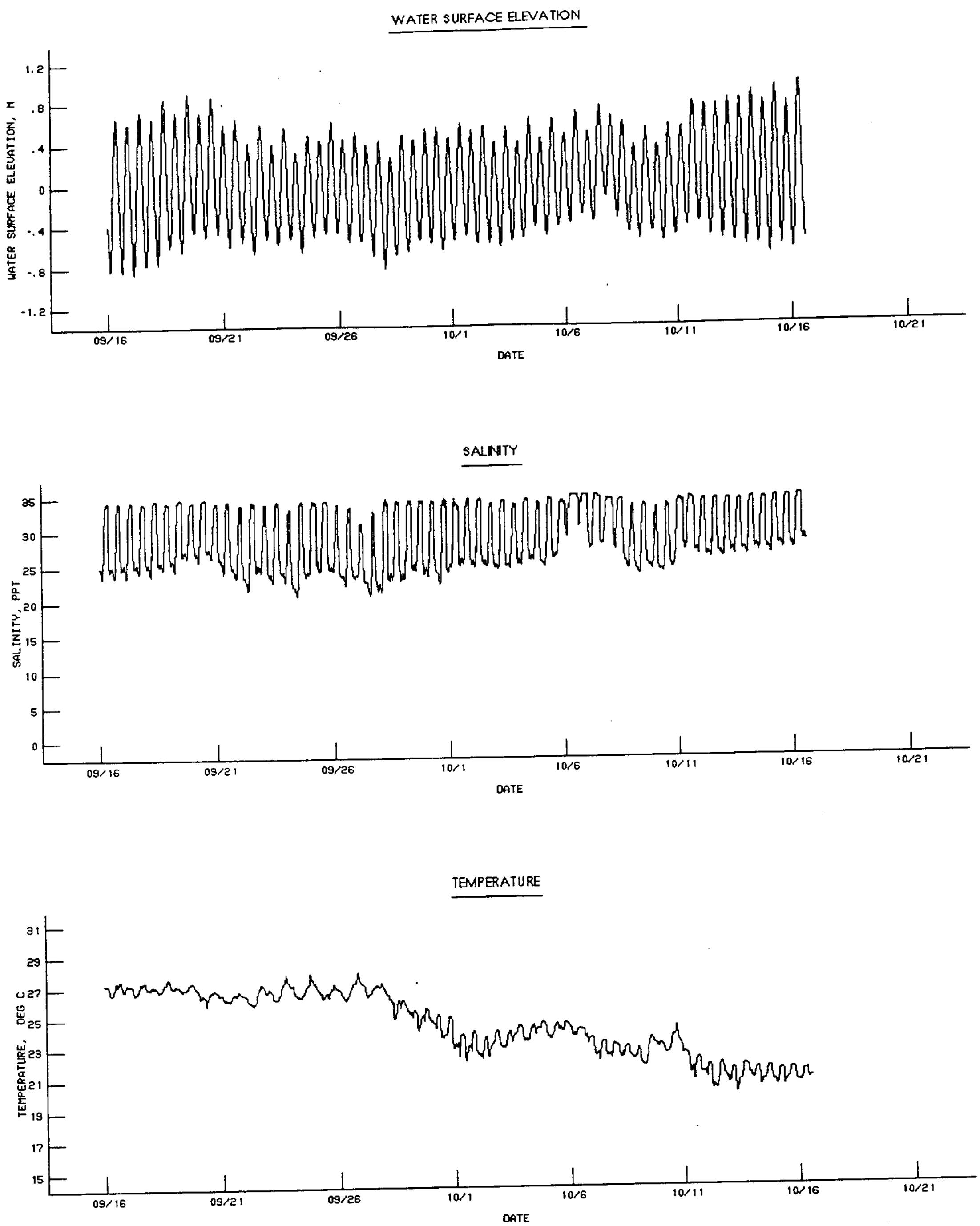


WATER SURFACE ELEVATION,
SALINITY, AND TEMPERATURE
STATION S3.0
08/12/93 - 09/16/93

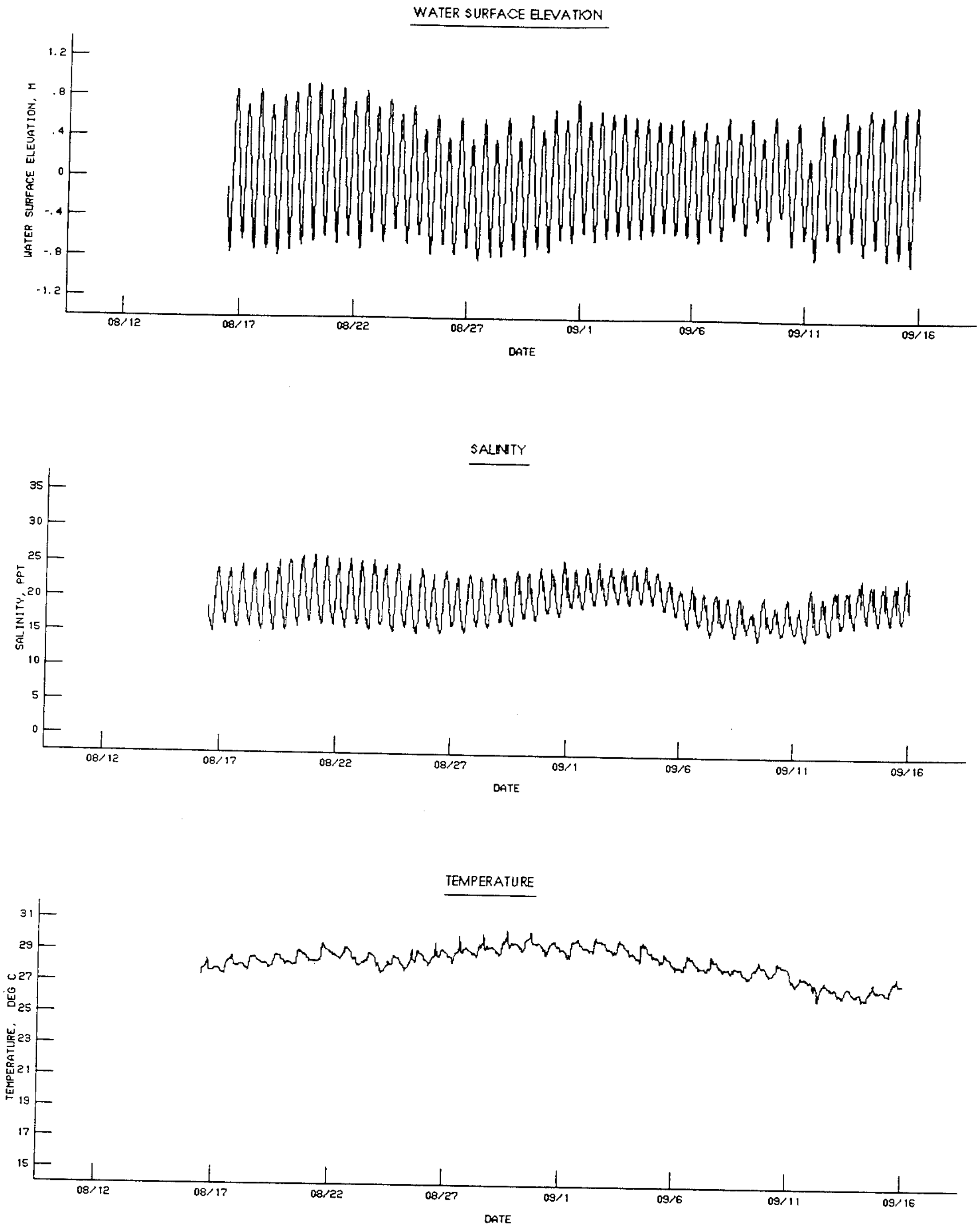


WATER SURFACE ELEVATION,
SALINITY, AND TEMPERATURE
STATION S3.5
08/12/93 - 09/16/93

Plate 6

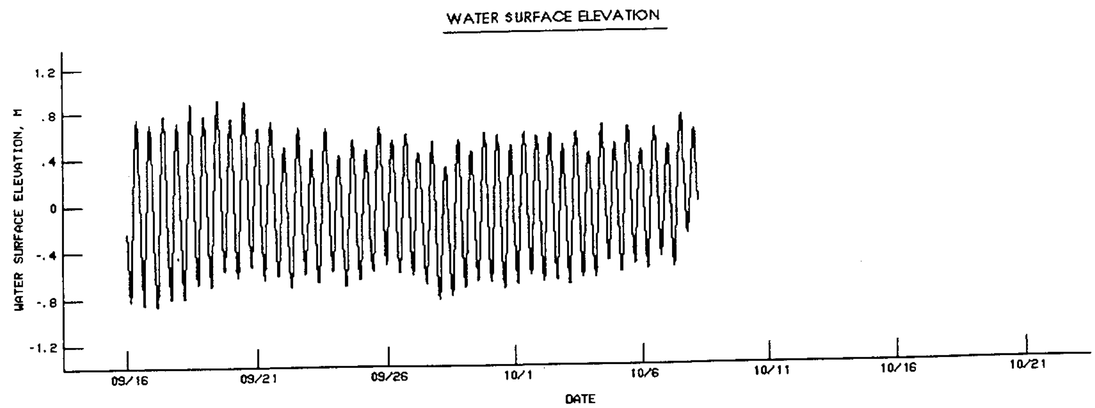


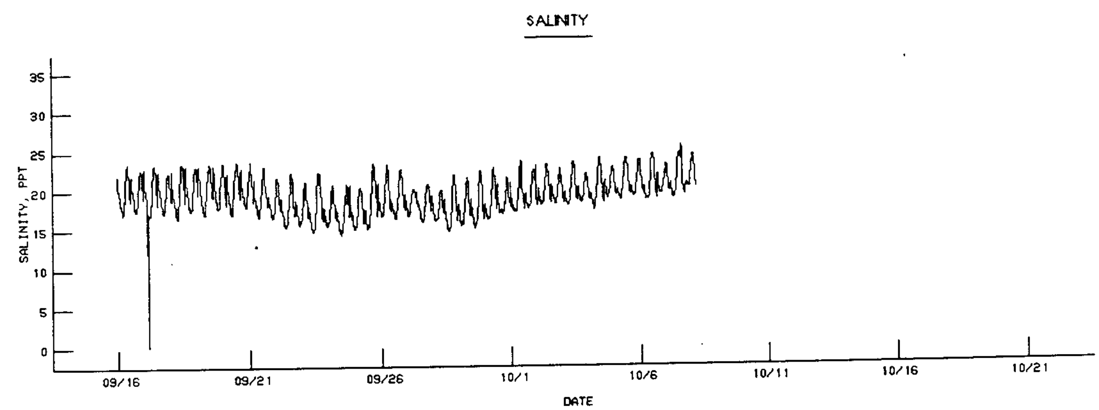
WATER SURFACE ELEVATION,
SALINITY, AND TEMPERATURE
STATION S3.5
09/16/93 - 10/18/93

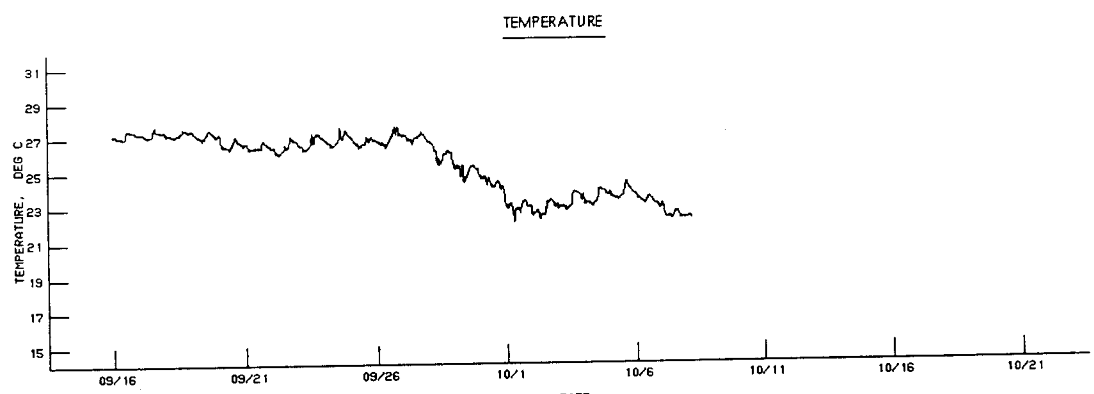


WATER SURFACE ELEVATION,
SALINITY, AND TEMPERATURE
STATION S4.0
08/12/93 - 09/16/93

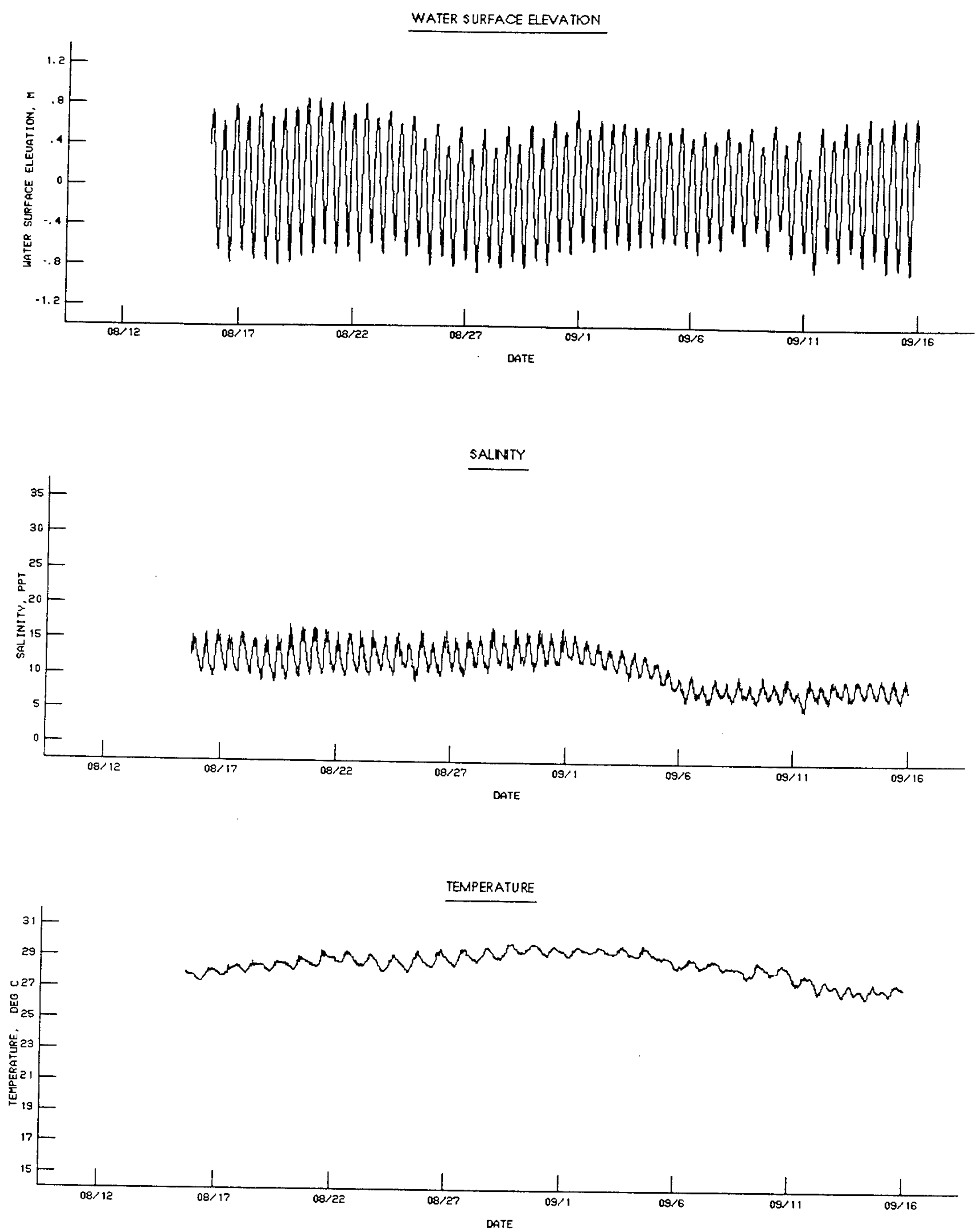
Plate 8



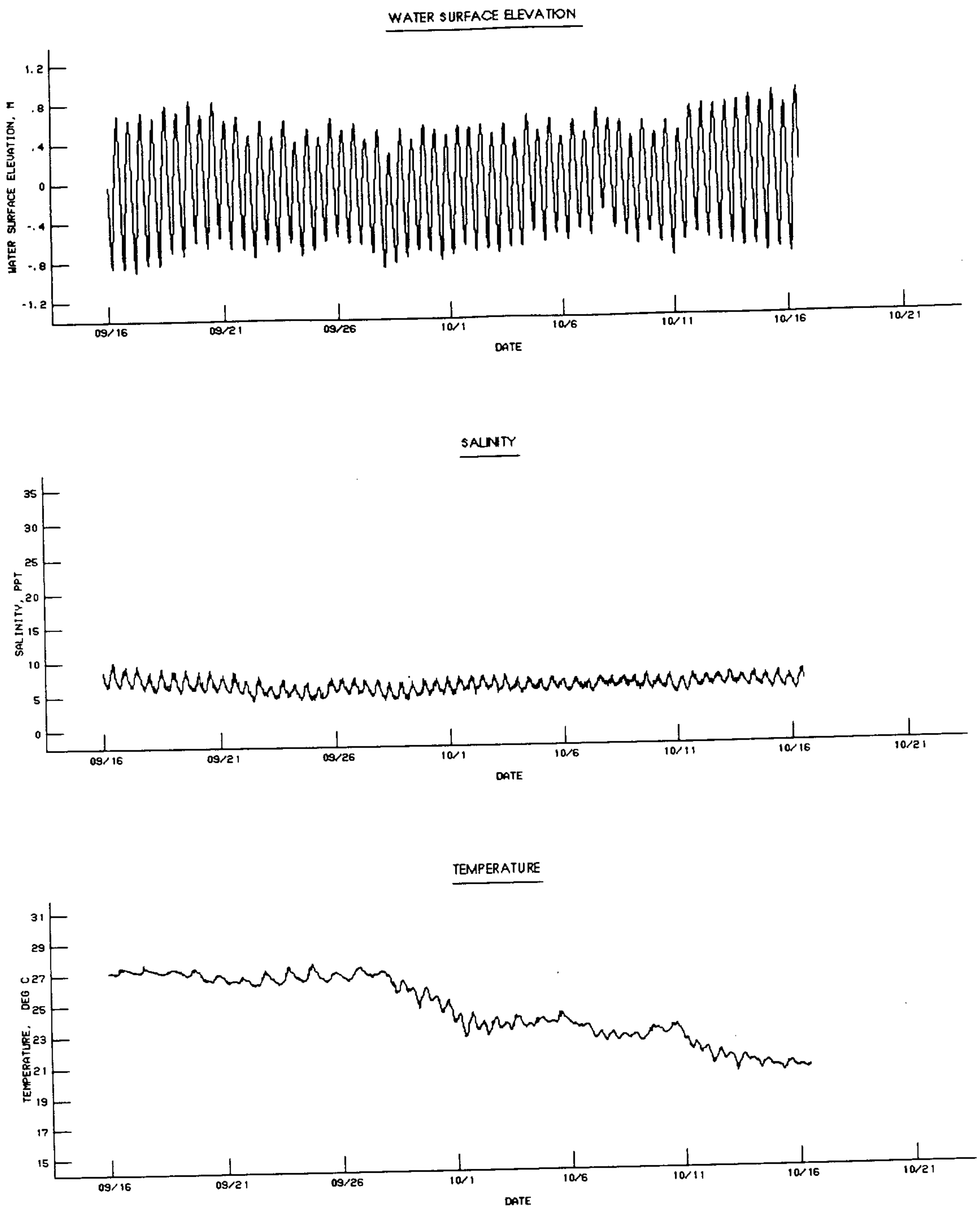




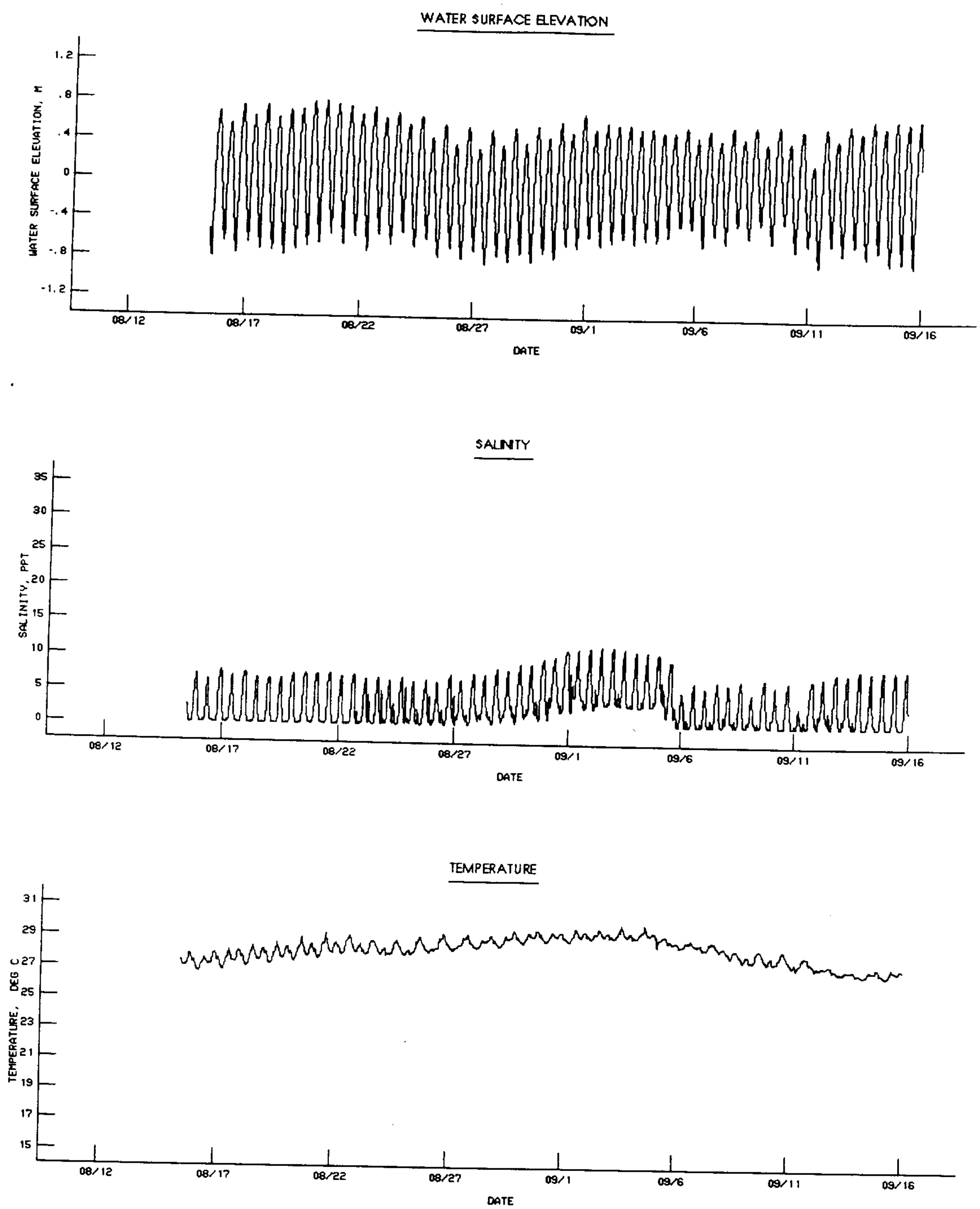
WATER SURFACE ELEVATION,
SALINITY, AND TEMPERATURE
STATION S4.0
09/16/93 - 10/18/93



WATER SURFACE ELEVATION,
SALINITY, AND TEMPERATURE
STATION S6.0
08/12/93 - 09/16/93

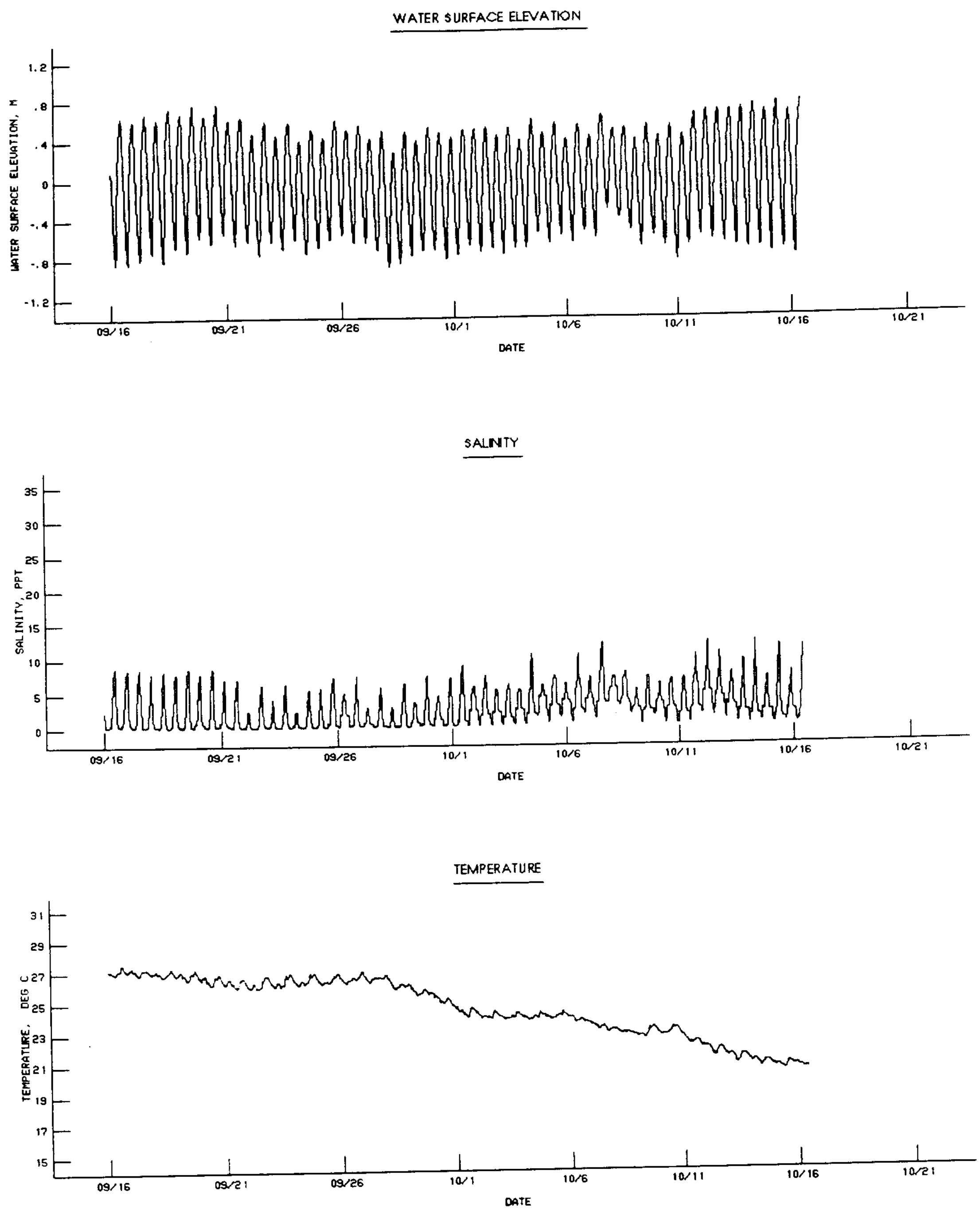


WATER SURFACE ELEVATION,
SALINITY, AND TEMPERATURE
STATION S6.0
09/16/93 - 10/18/93

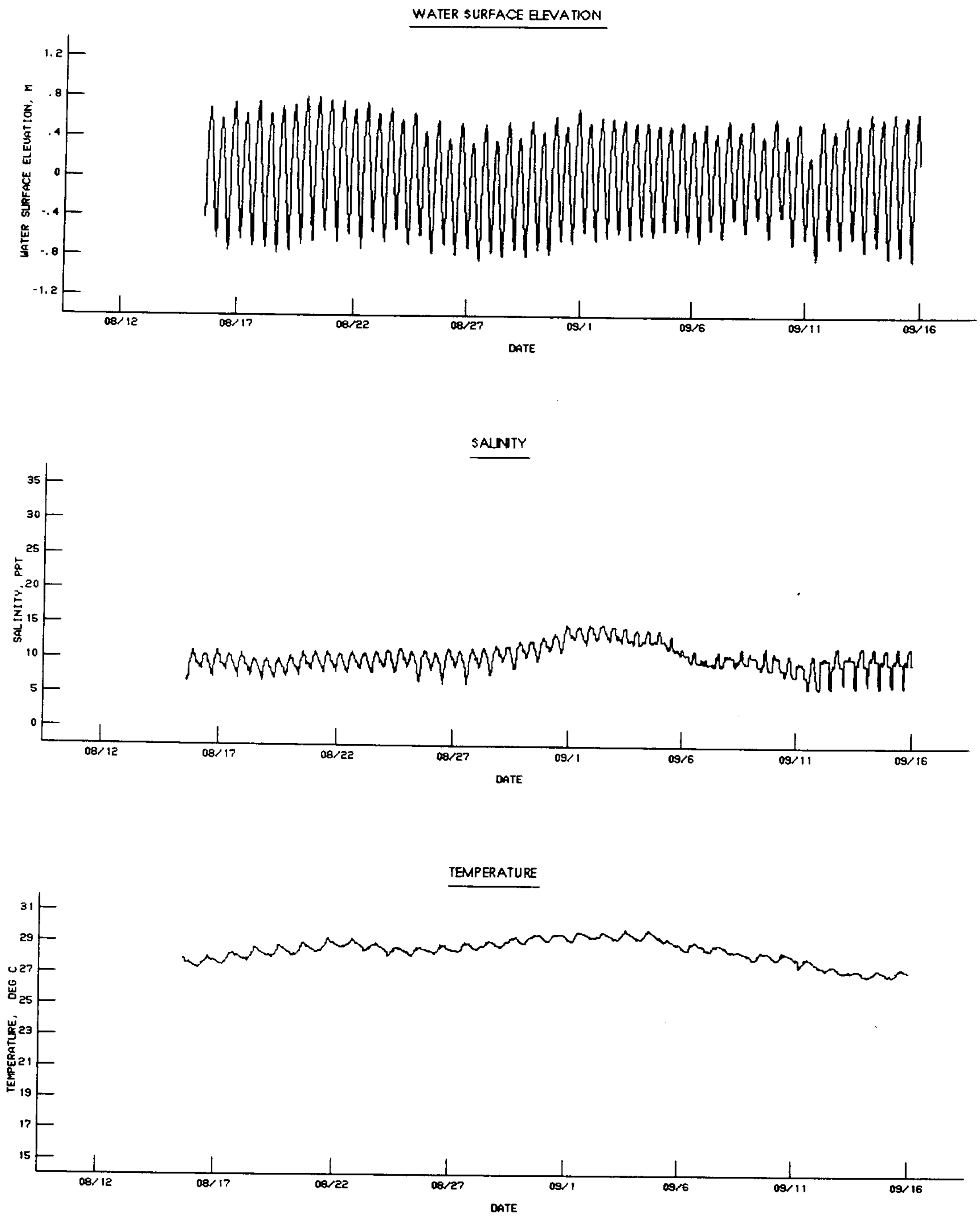


WATER SURFACE ELEVATION,
SALINITY, AND TEMPERATURE
STATION S7.0
08/12/93 - 09/16/93

Plate 12

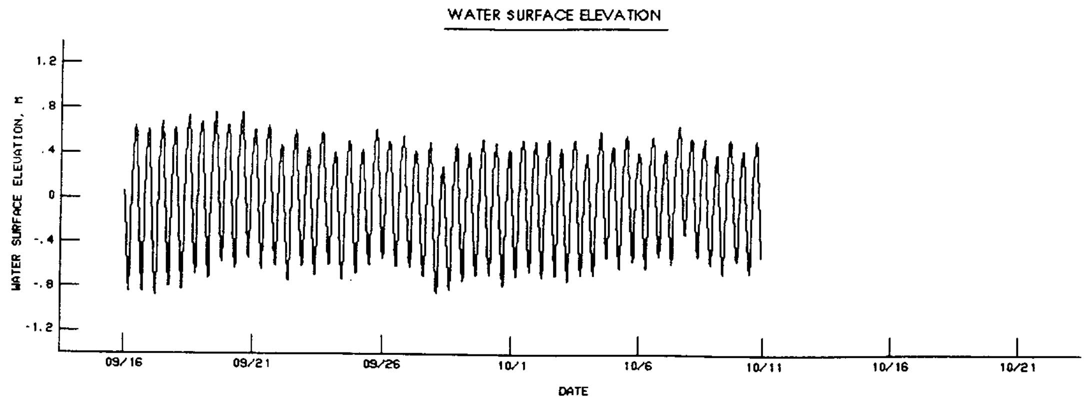


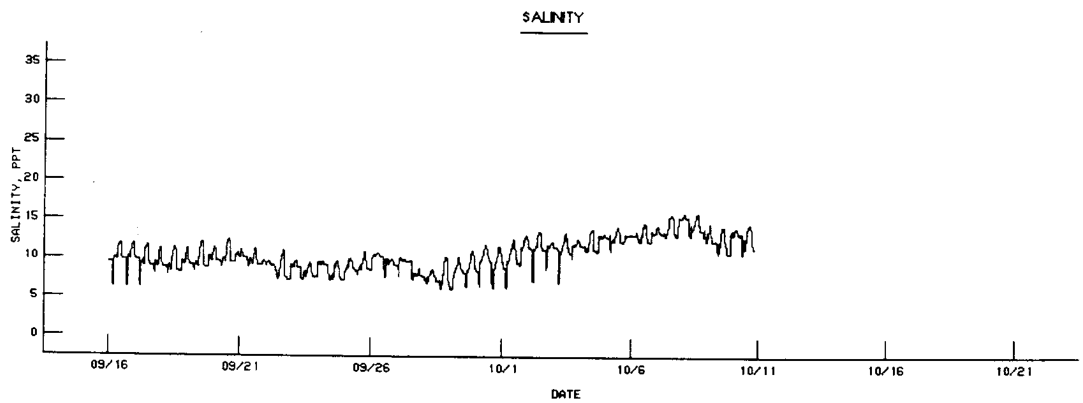
WATER SURFACE ELEVATION,
SALINITY, AND TEMPERATURE
STATION S7.0
09/16/93 - 10/18/93

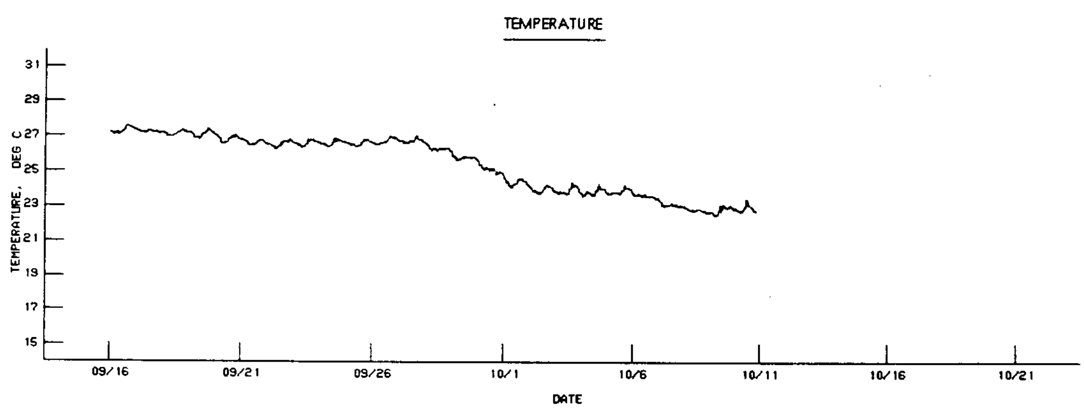


WATER SURFACE ELEVATION,
SALINITY, AND TEMPERATURE
STATION S8.0
08/12/93 - 09/16/93

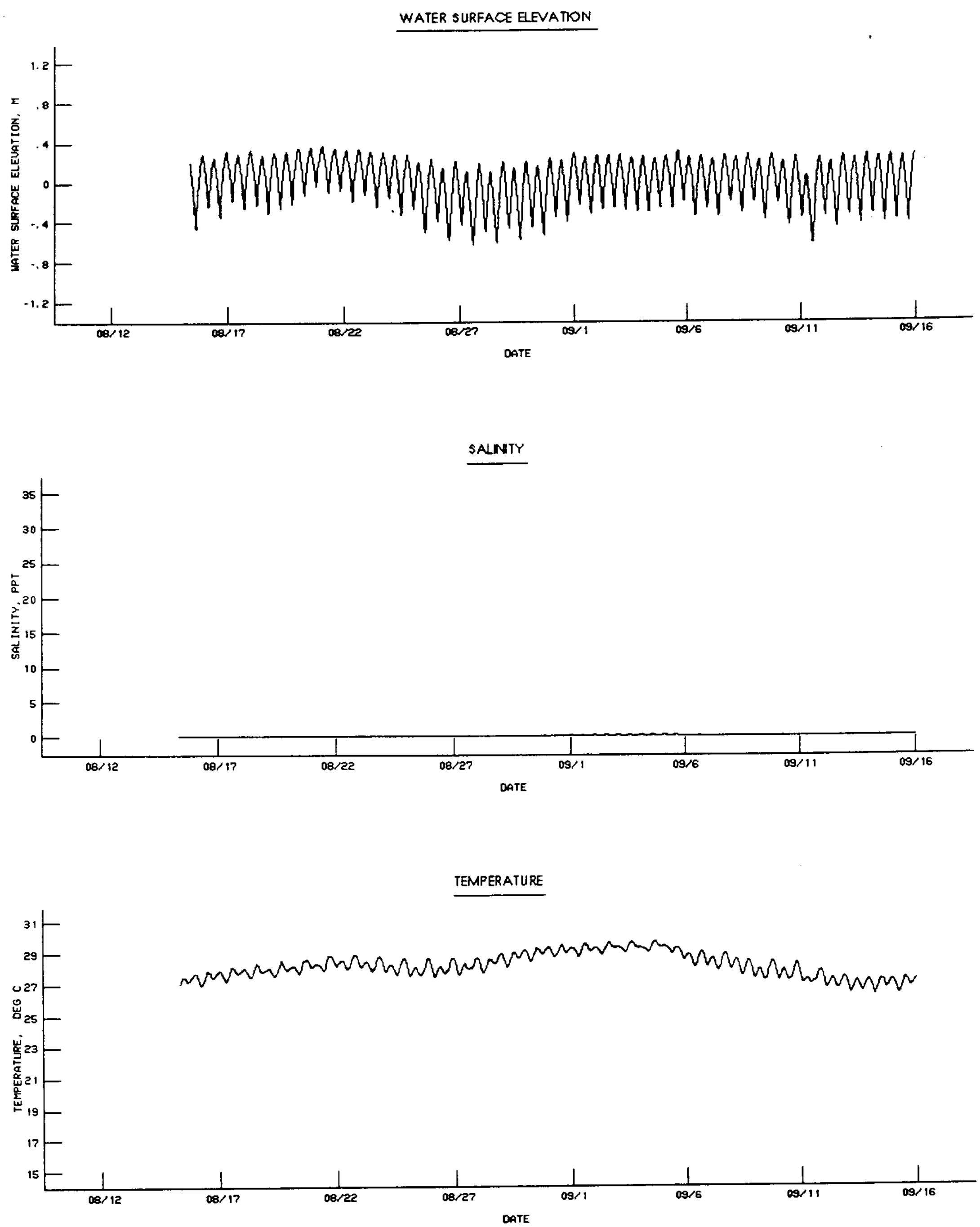
Plate 14





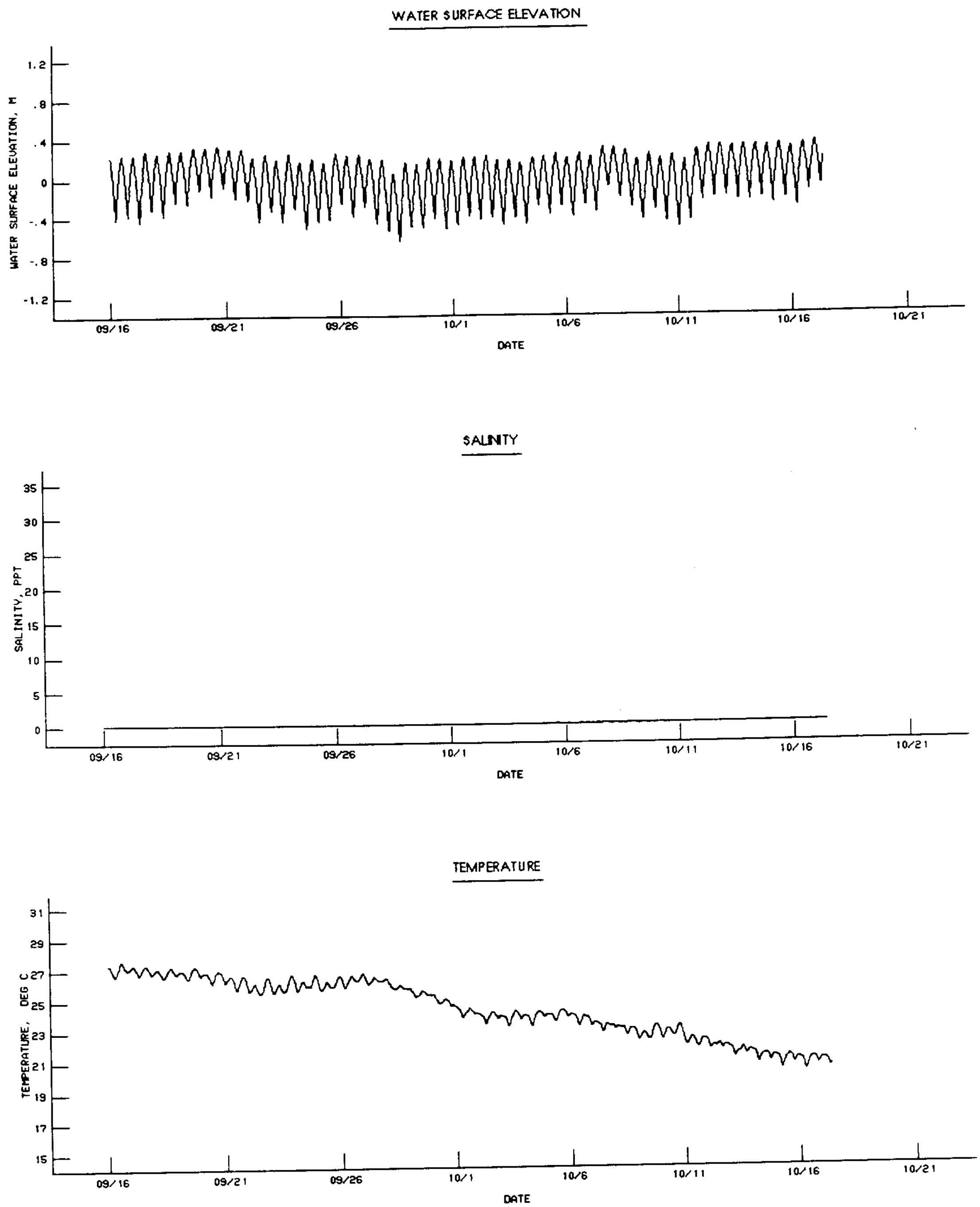


WATER SURFACE ELEVATION,
SALINITY, AND TEMPERATURE
STATION S8.0
09/16/93 - 10/18/93

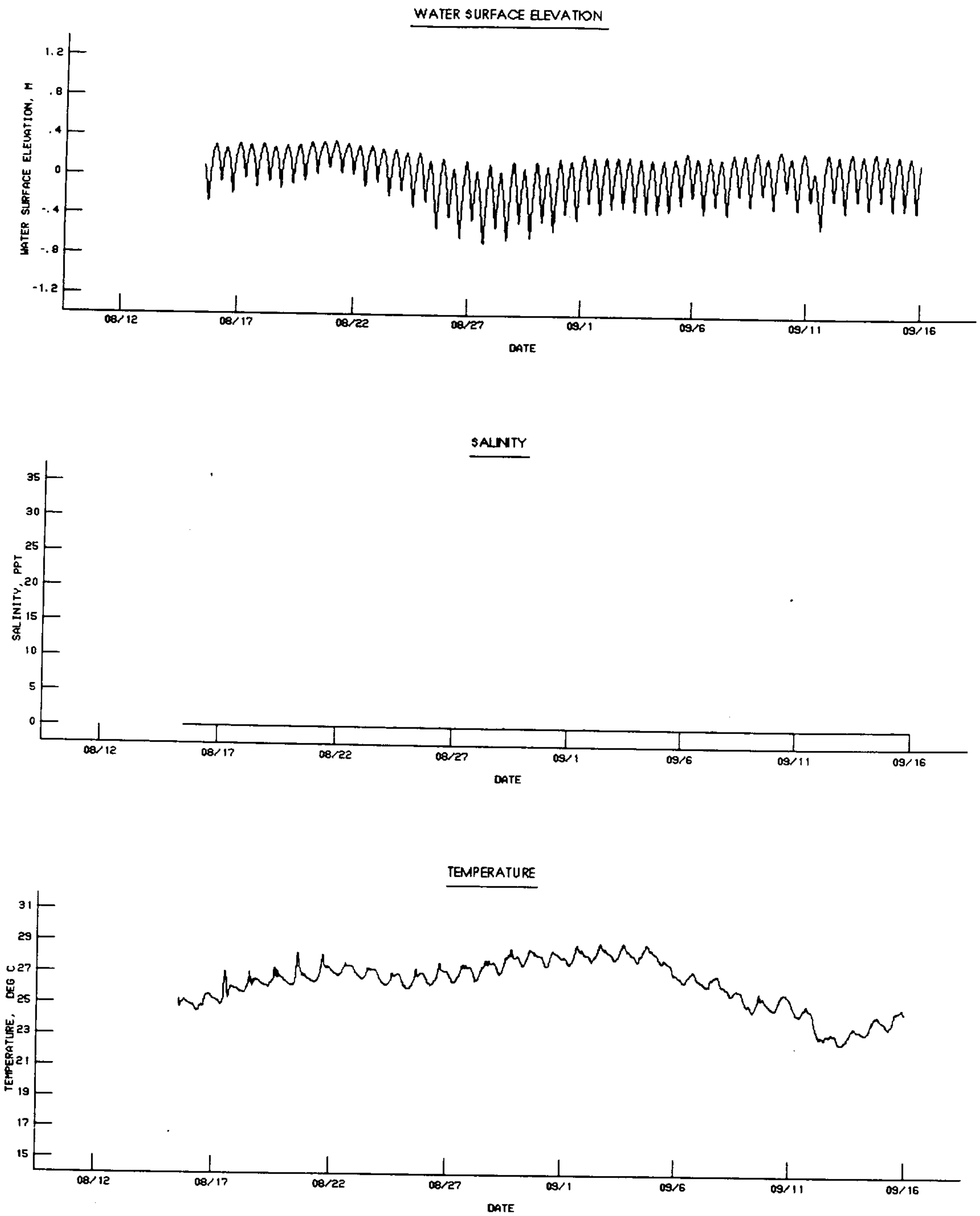


WATER SURFACE ELEVATION,
SALINITY, AND TEMPERATURE
STATION S9.0
08/12/93 - 09/16/93

Plate 16

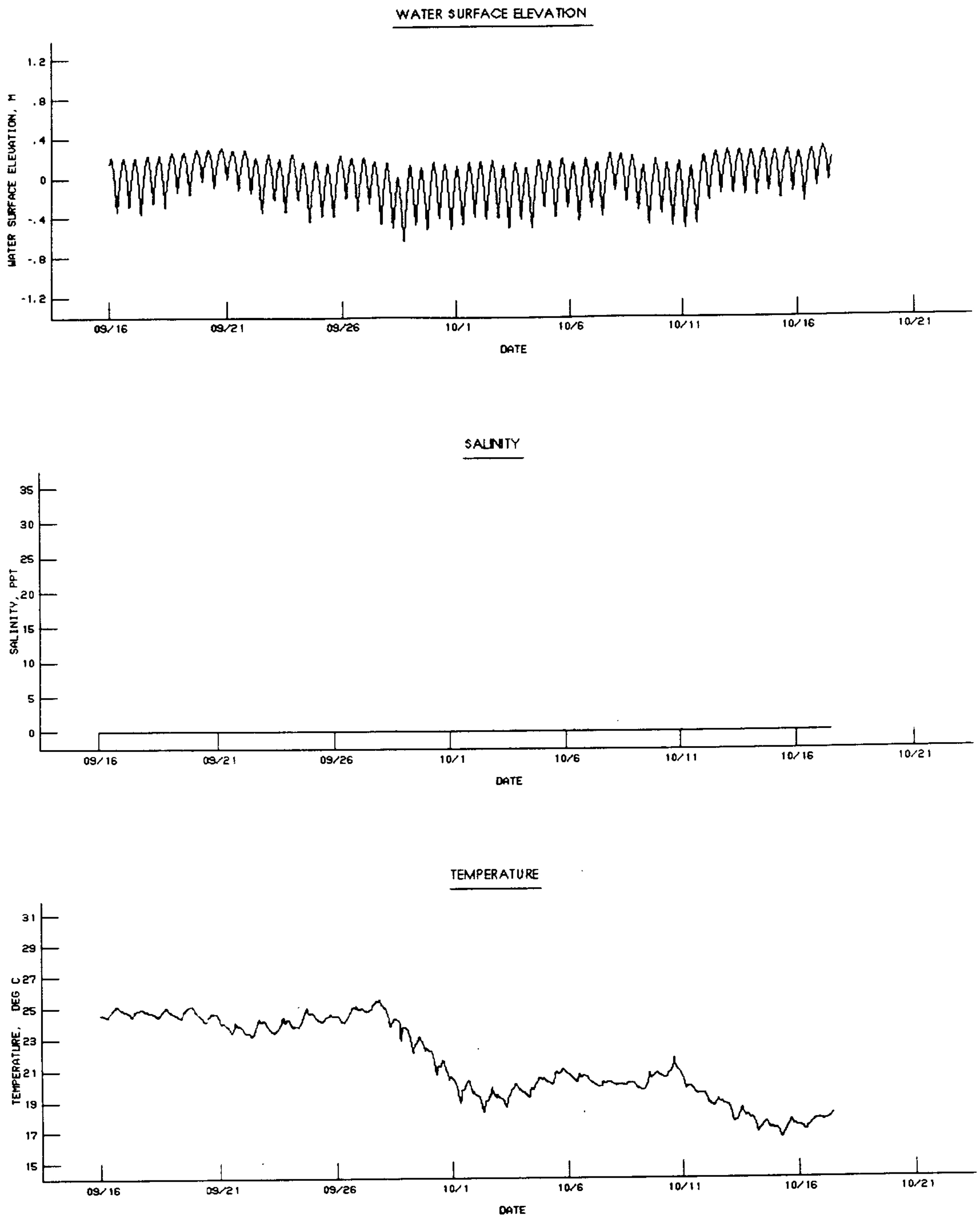


WATER SURFACE ELEVATION,
SALINITY, AND TEMPERATURE
STATION S9.0
09/16/93 - 10/18/93



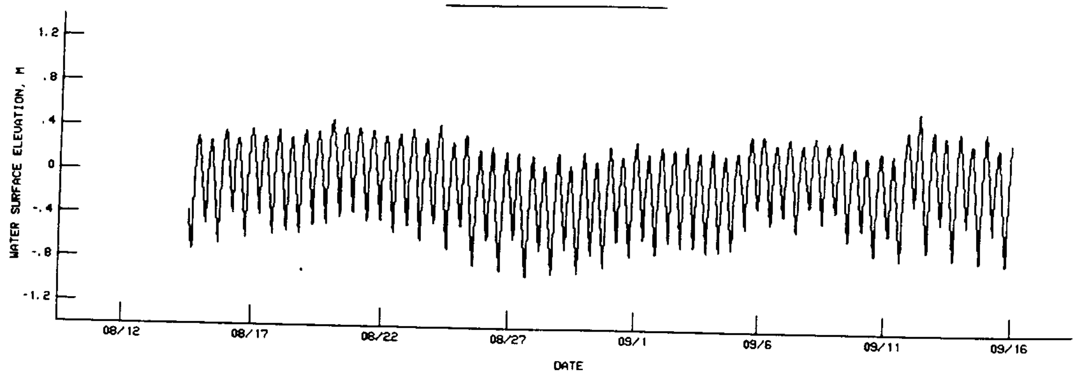
WATER SURFACE ELEVATION,
SALINITY, AND TEMPERATURE
STATION S10.0
08/12/93 - 09/16/93

Plate 18

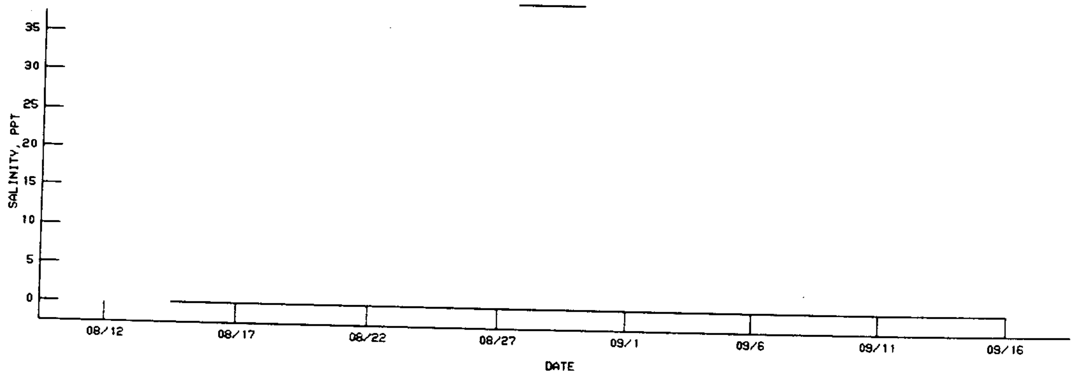


WATER SURFACE ELEVATION,
SALINITY, AND TEMPERATURE
STATION S10.0
09/16/93 - 10/18/93

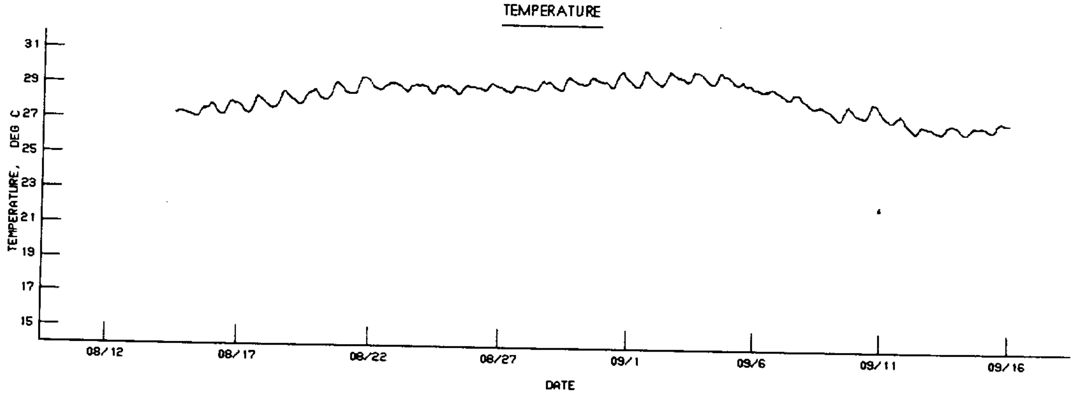
WATER SURFACE ELEVATION



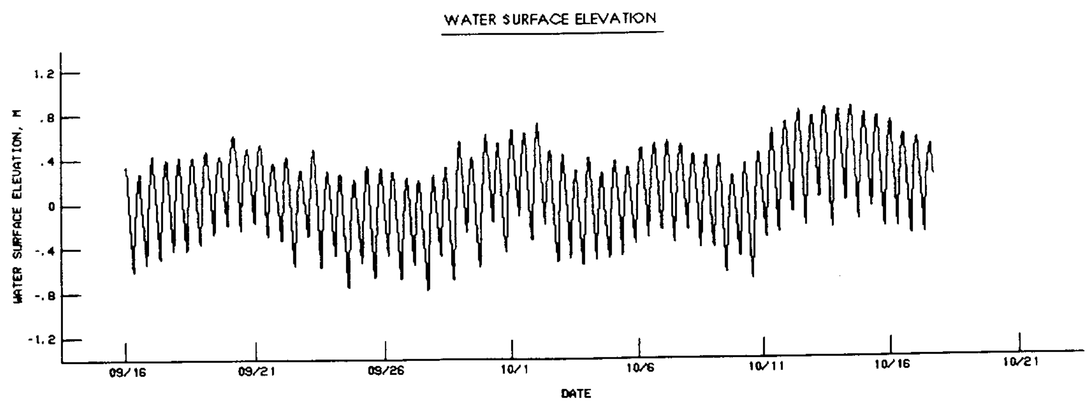
SALINITY

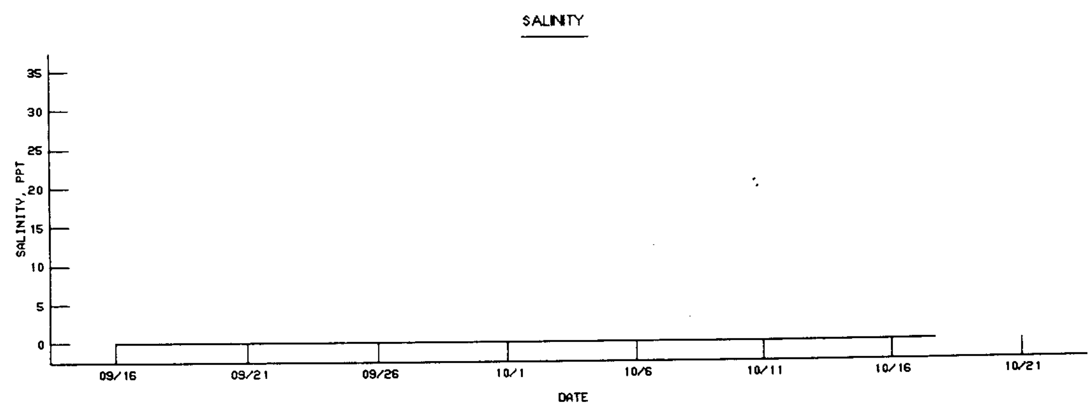


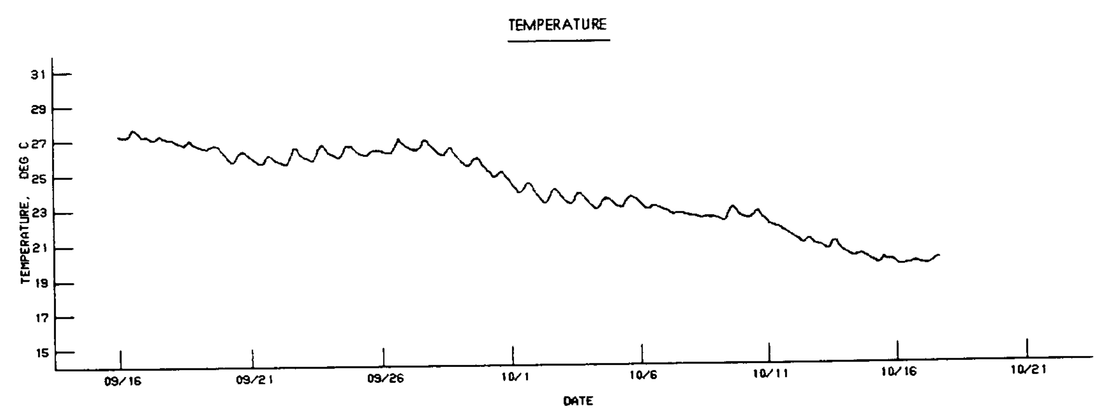
TEMPERATURE



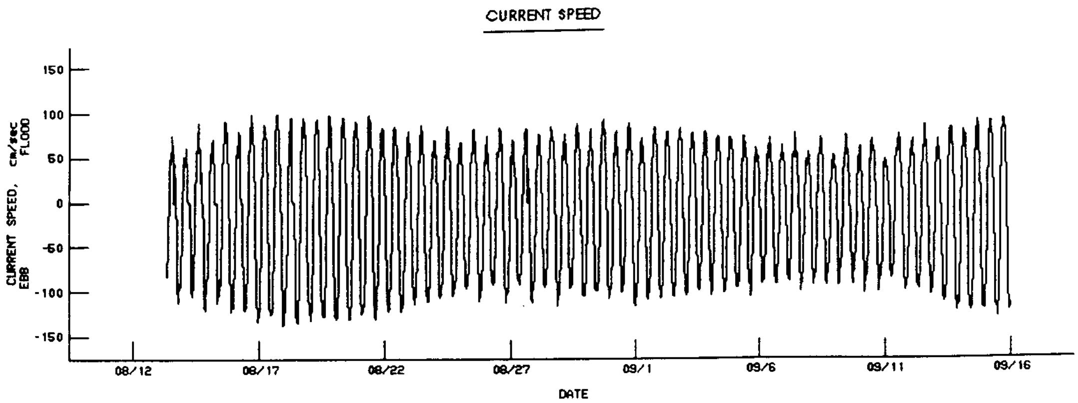
WATER SURFACE ELEVATION,
SALINITY, AND TEMPERATURE
STATION S11.0
08/12/93 - 09/16/93

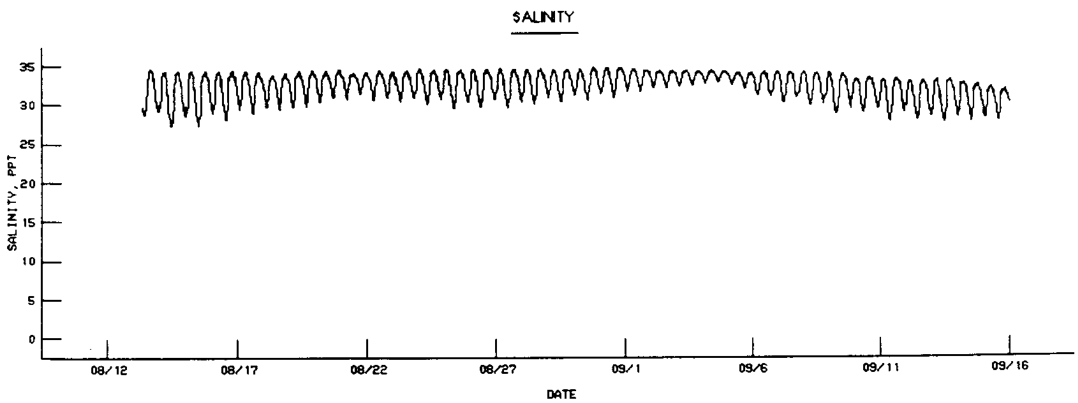


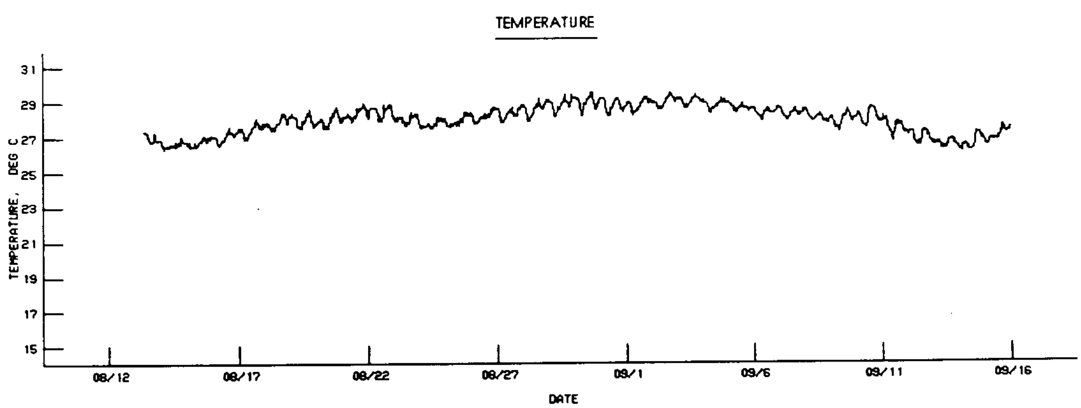




WATER SURFACE ELEVATION,
SALINITY, AND TEMPERATURE
STATION S11.0
09/16/93 - 10/18/93



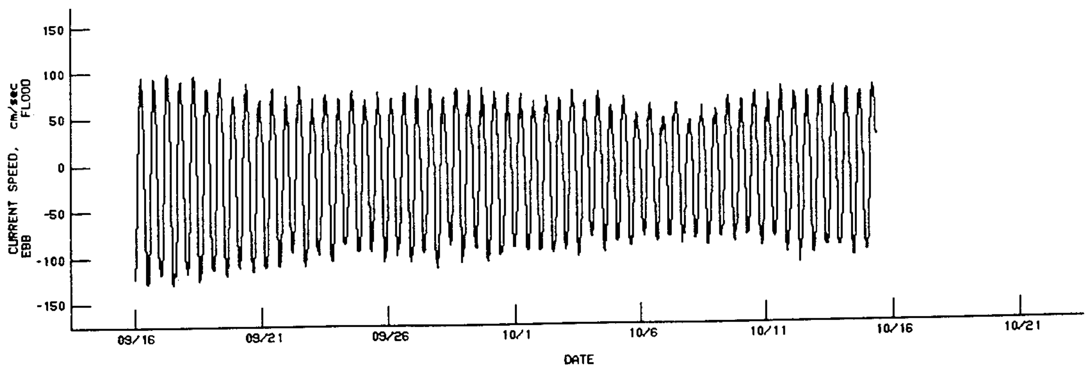




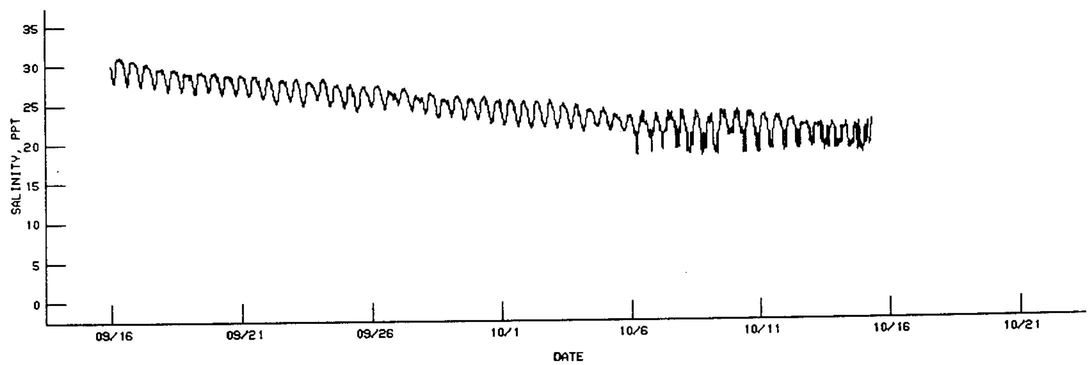
CURRENT SPEED, SALINITY,
AND TEMPERATURE
STATION S1.2, MIDDEPTH
08/12/93 - 09/16/93

Plate 22

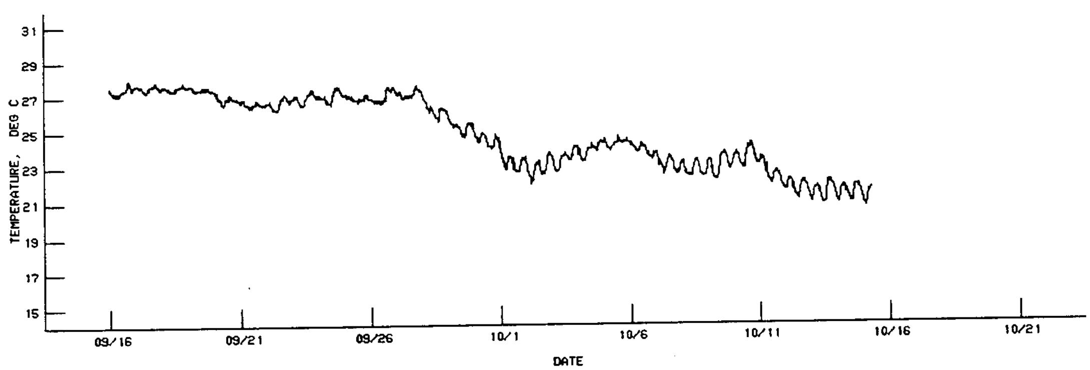
CURRENT SPEED



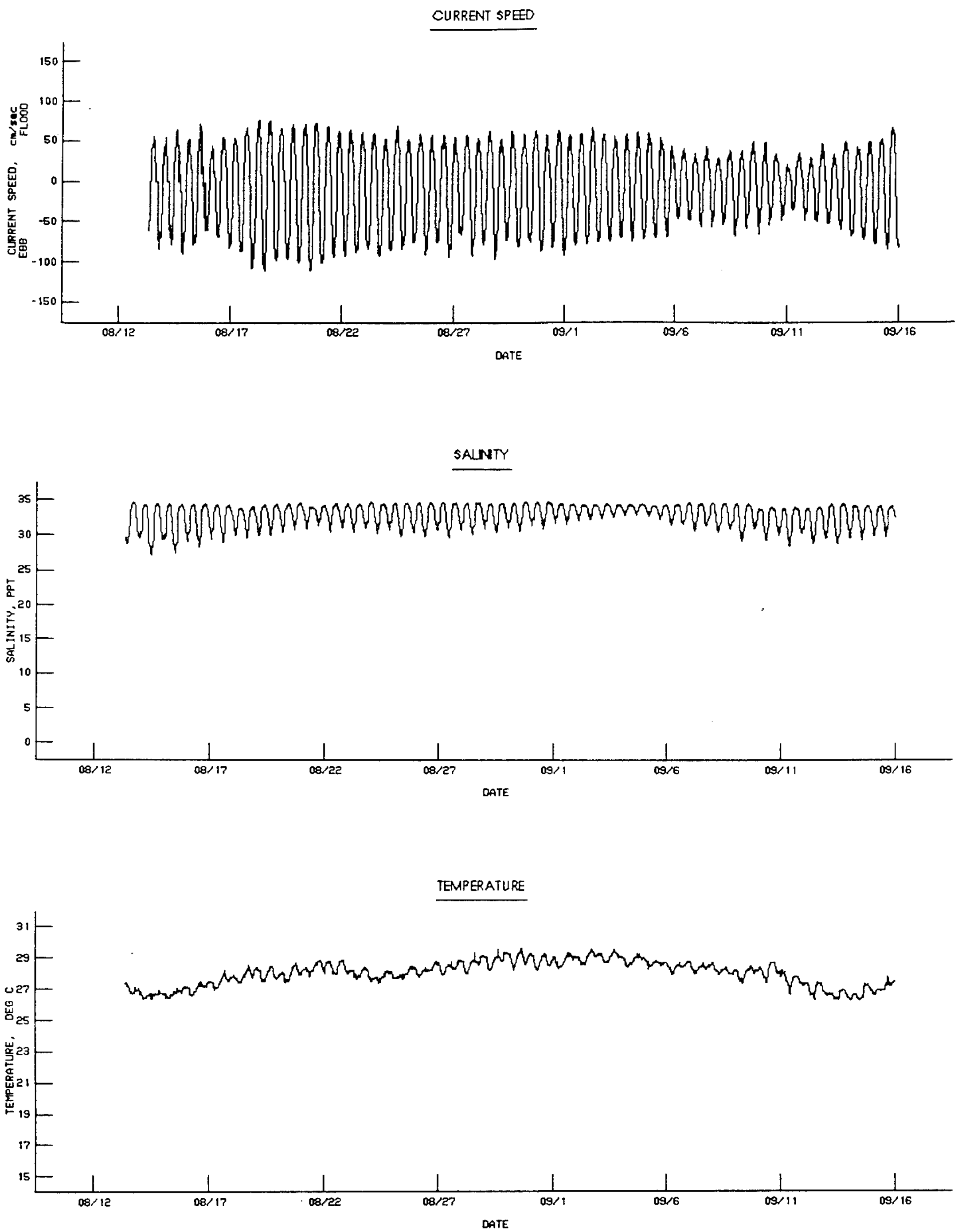
SALINITY



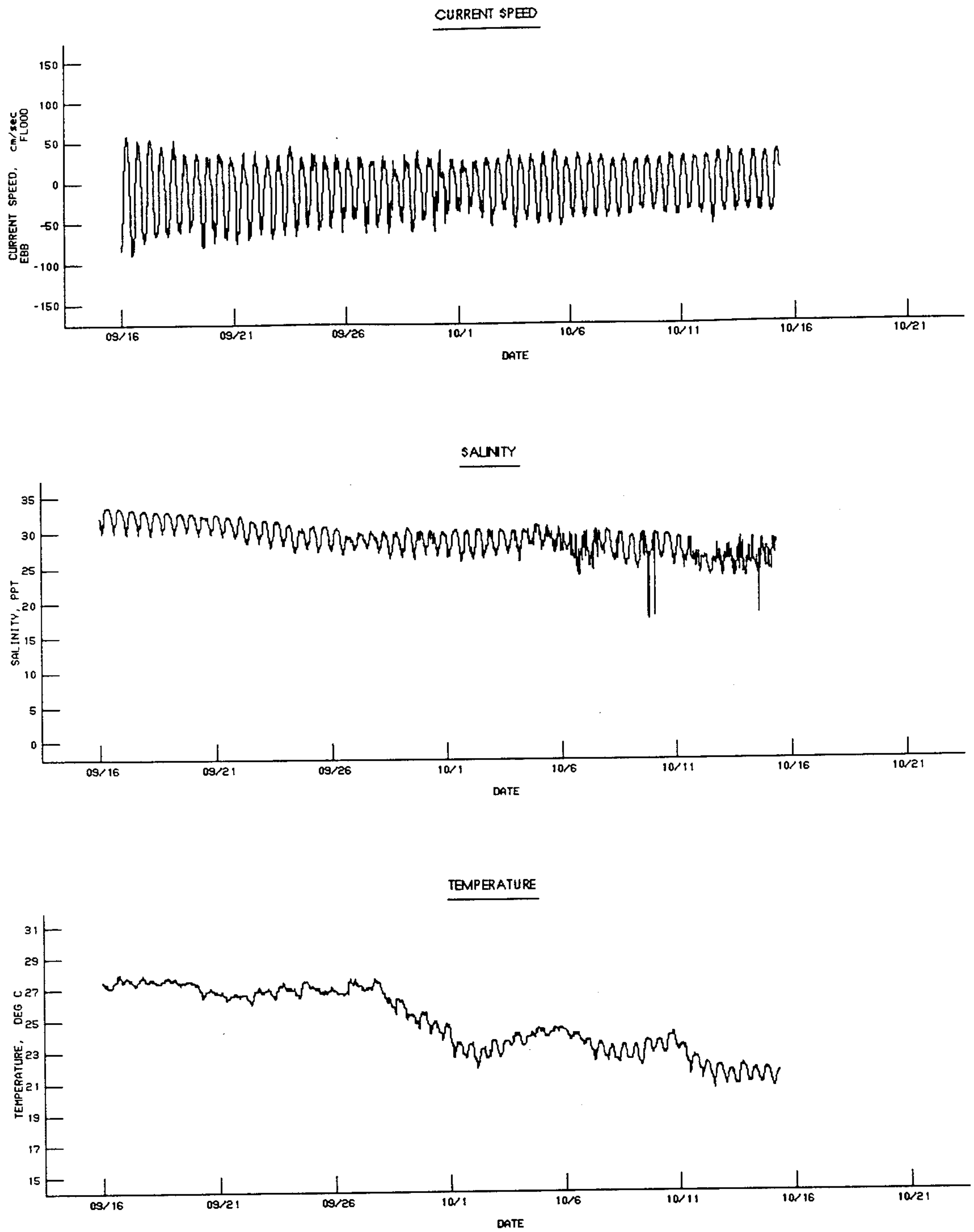
TEMPERATURE



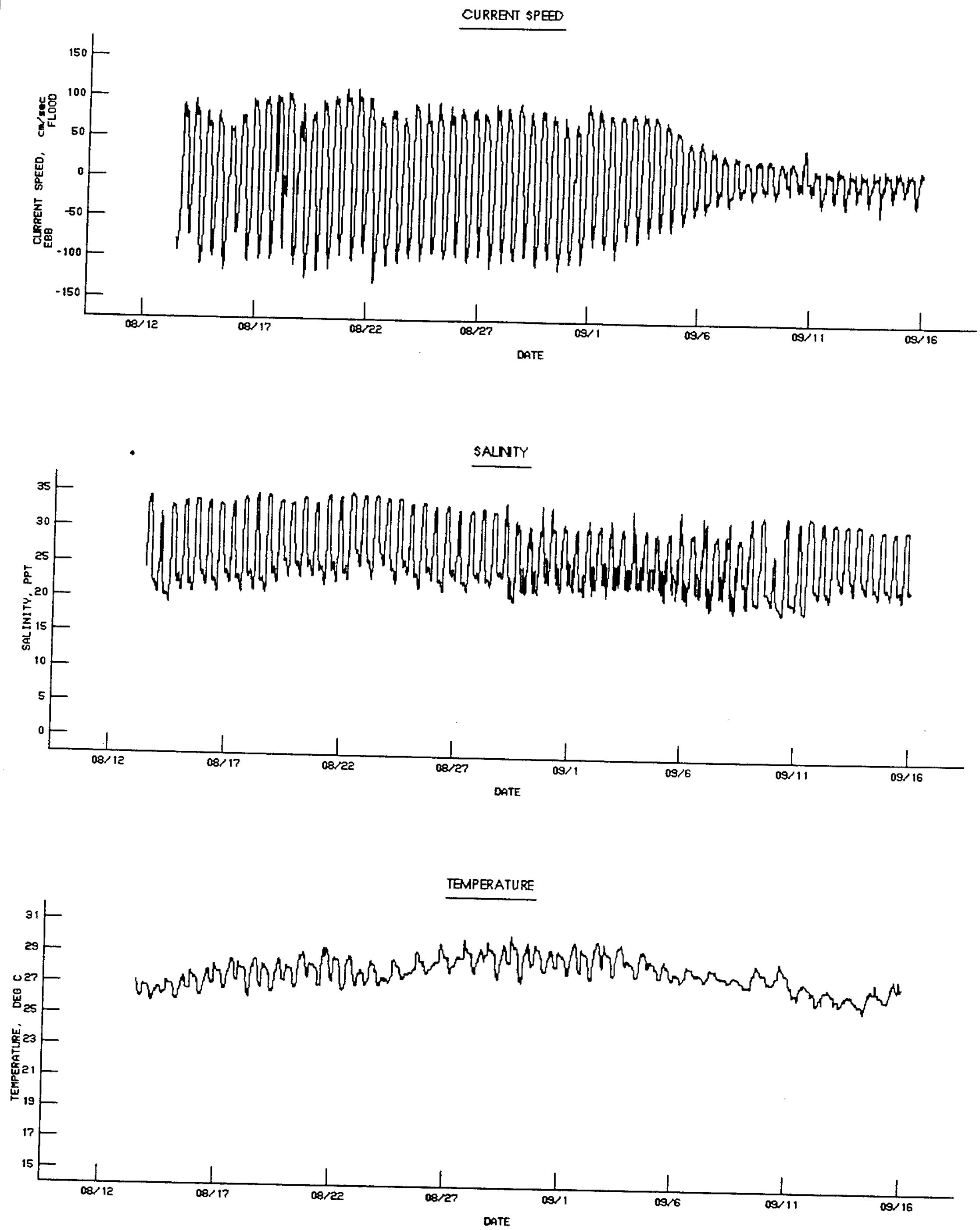
CURRENT SPEED, SALINITY, AND TEMPERATURE
STATION S1.2, MIDDEPTH
09/16/93 - 10/18/93



**CURRENT SPEED, SALINITY, AND TEMPERATURE
STA S1.2, NEAR BOTTOM
08/12/93 - 09/16/93**

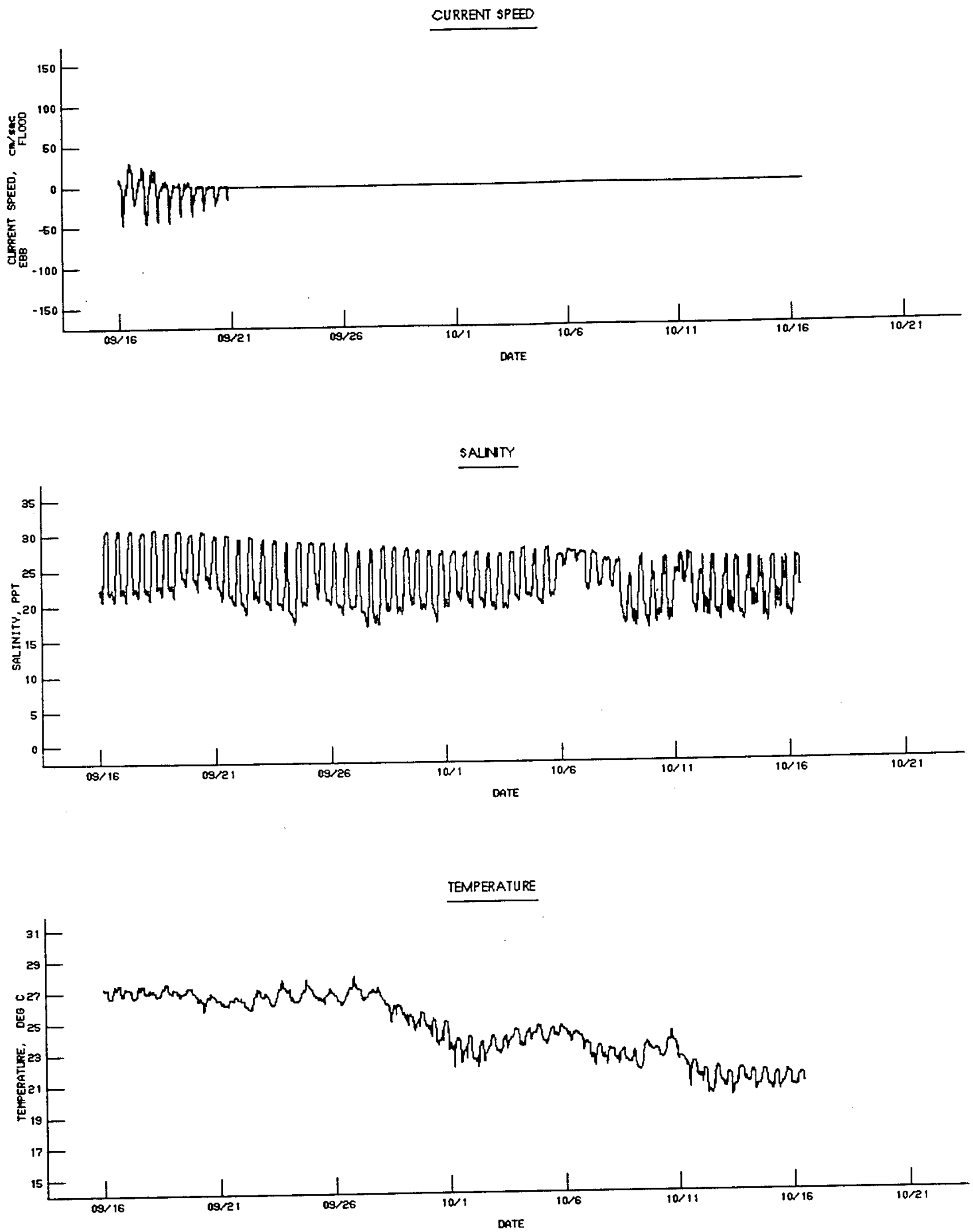


CURRENT SPEED, SALINITY,
AND TEMPERATURE
STA S1.2, NEAR BOTTOM
09/16/93 - 10/18/93

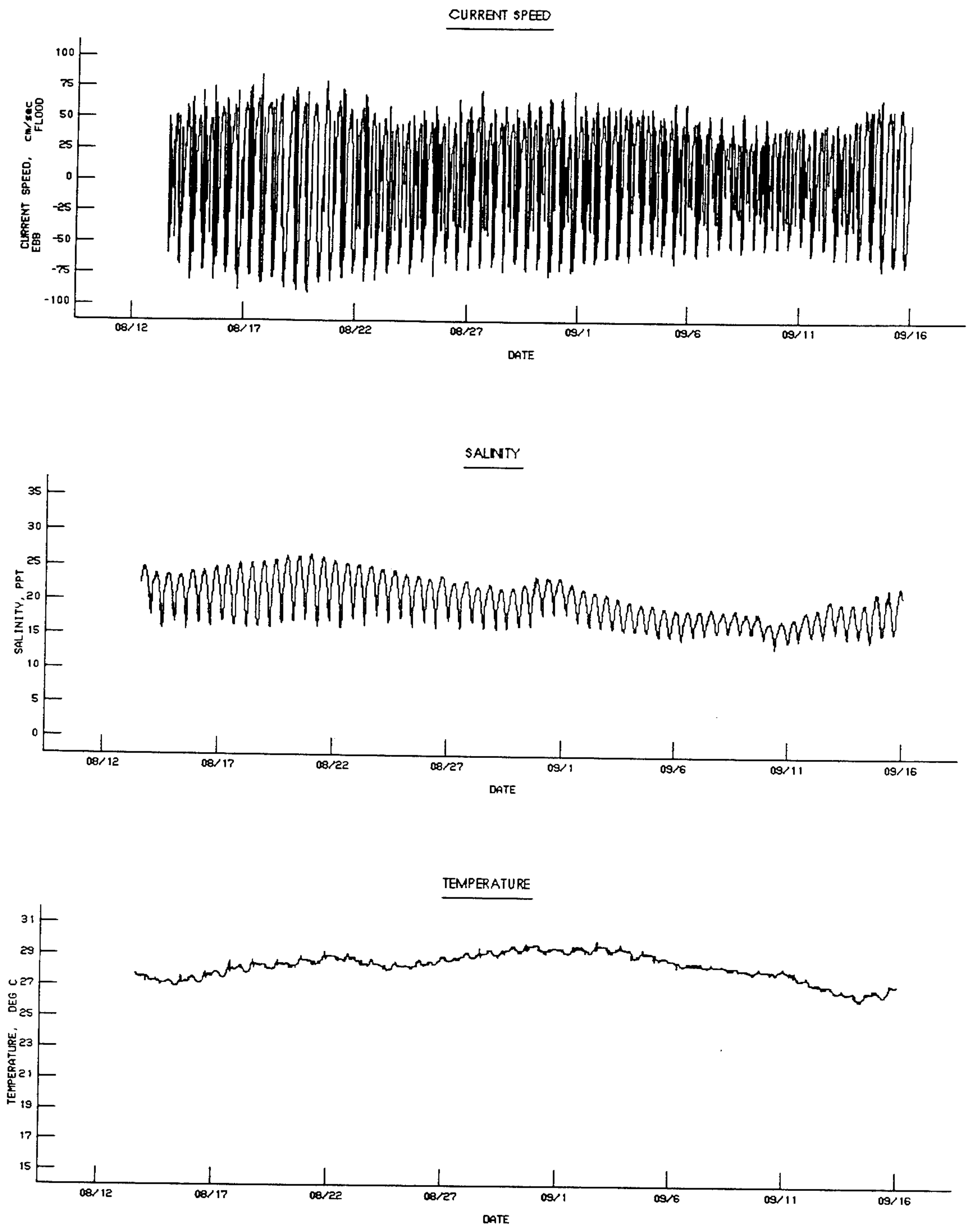


CURRENT SPEED, SALINITY,
AND TEMPERATURE
STATION S3.4, MIDDEPTH
08/12/93 - 09/16/93

Plate 26

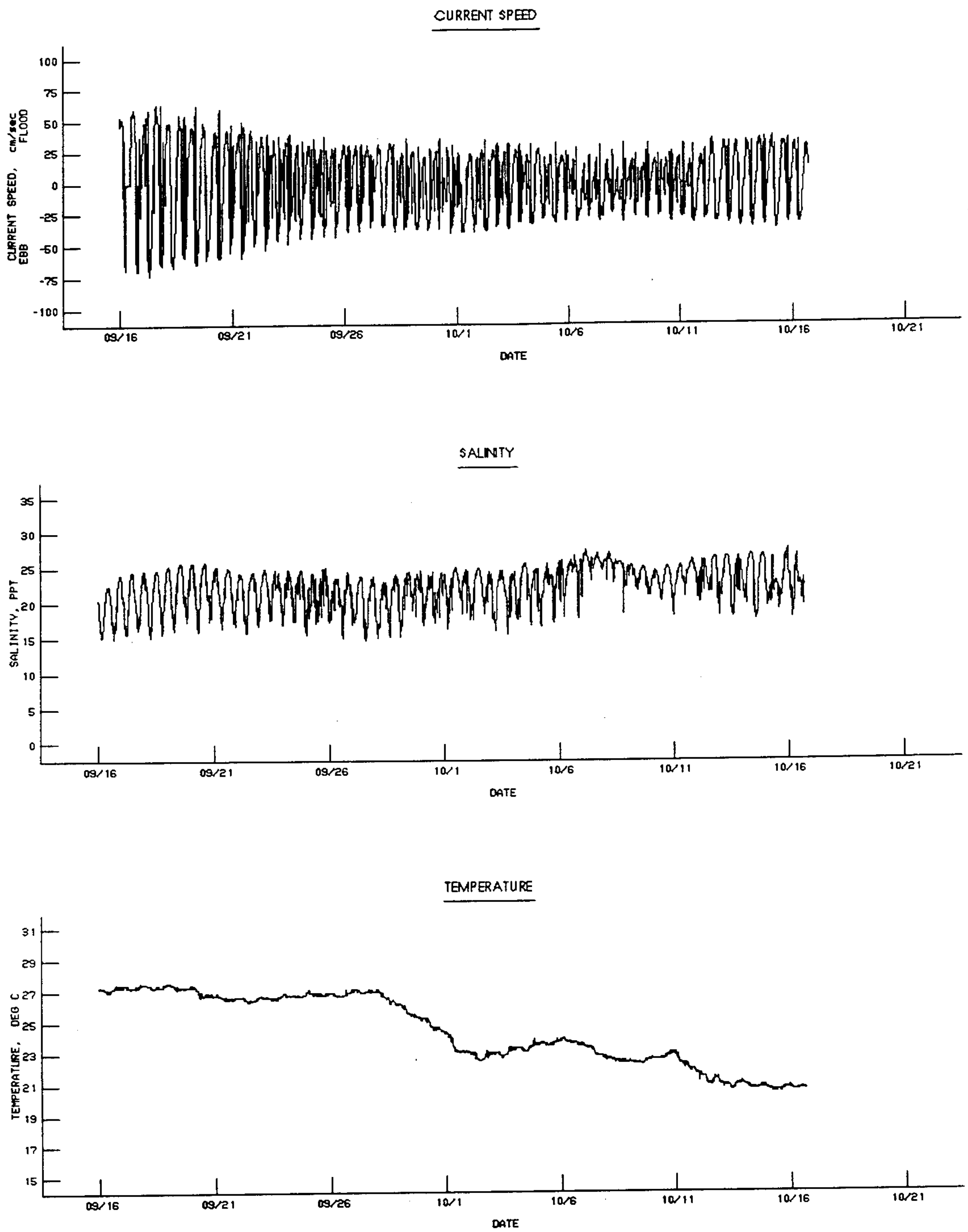


CURRENT SPEED, SALINITY,
AND TEMPERATURE
STATION S3.4, MIDDEPTH
09/16/93 - 10/18/93

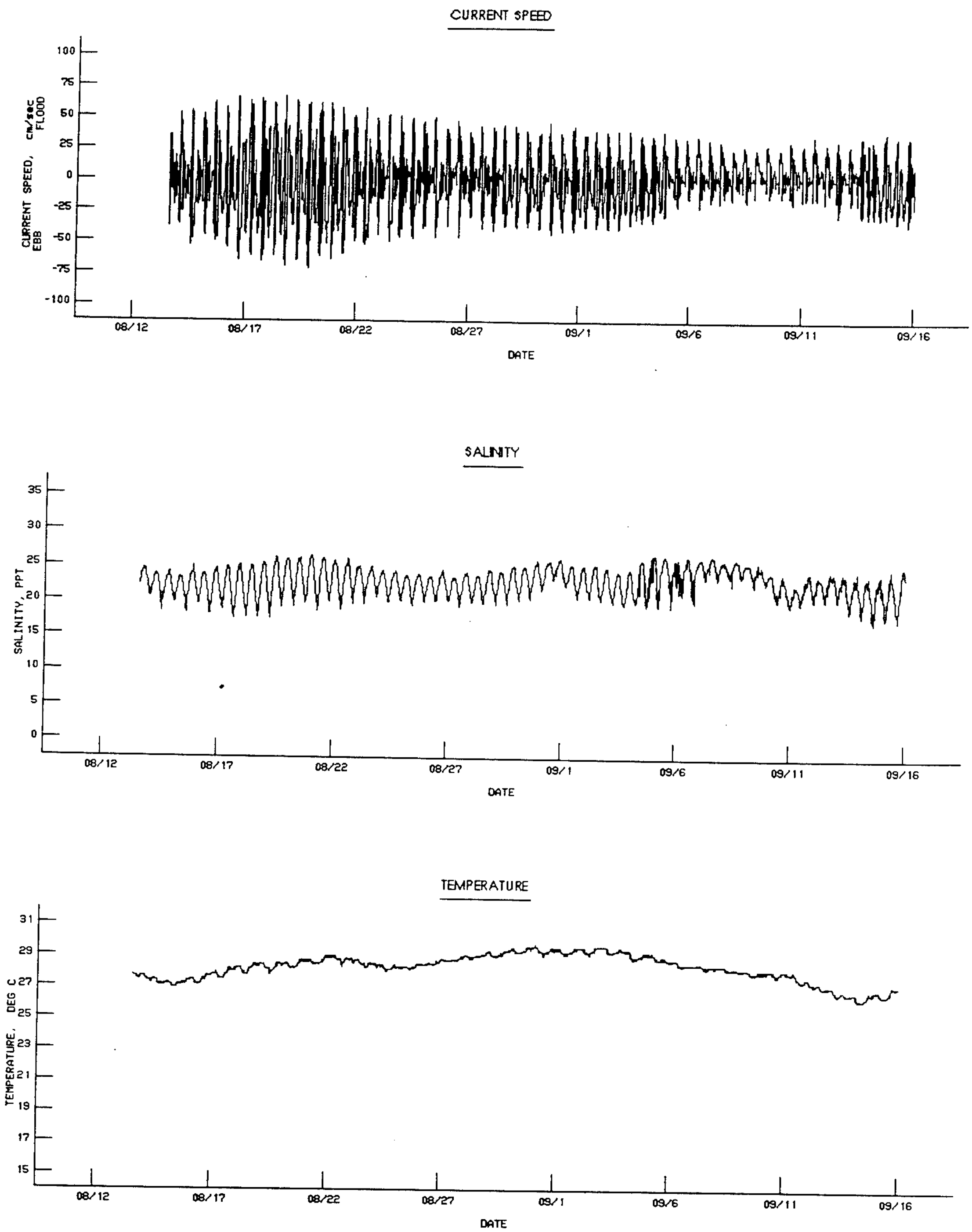


CURRENT SPEED, SALINITY, AND TEMPERATURE STATION S3.9, MIDDEPTH 08/12/93 - 09/16/93

Plate 28

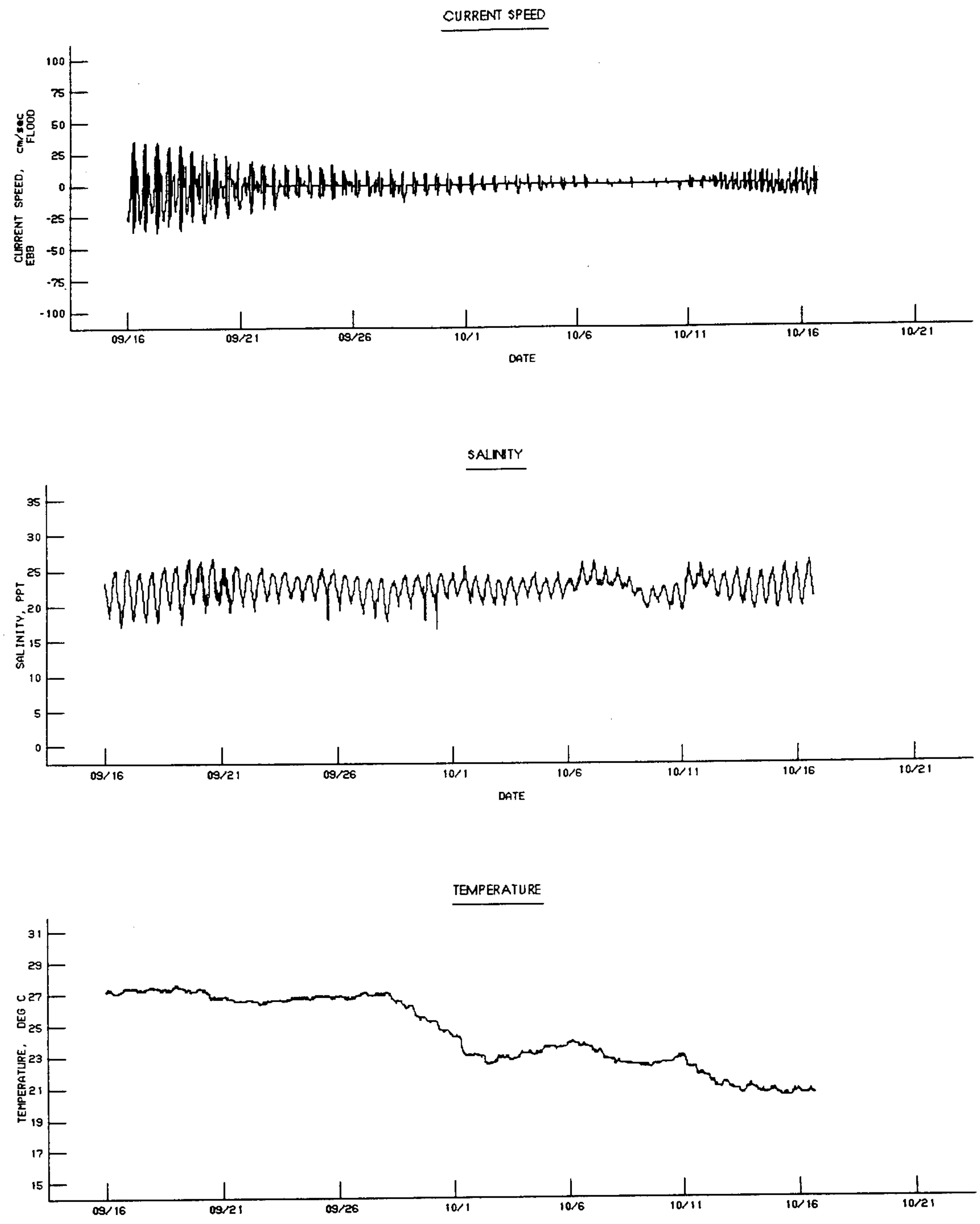


CURRENT SPEED, SALINITY, AND TEMPERATURE STATION S3.9, MIDDEPTH 09/16/93 - 10/18/93

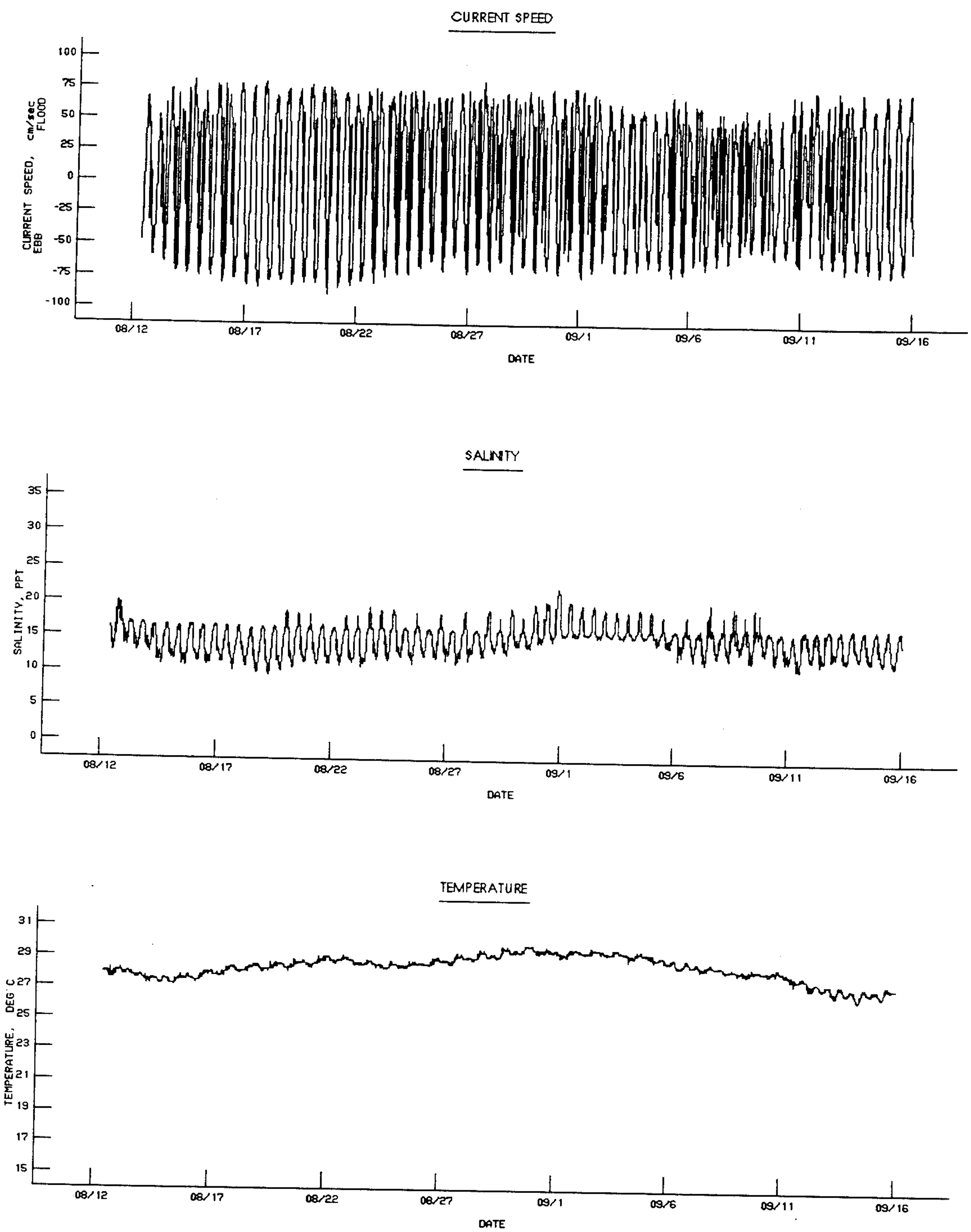


CURRENT SPEED, SALINITY, AND TEMPERATURE
STA S3.9, NEAR BOTTOM
08/12/93 - 09/16/93

Plate 30

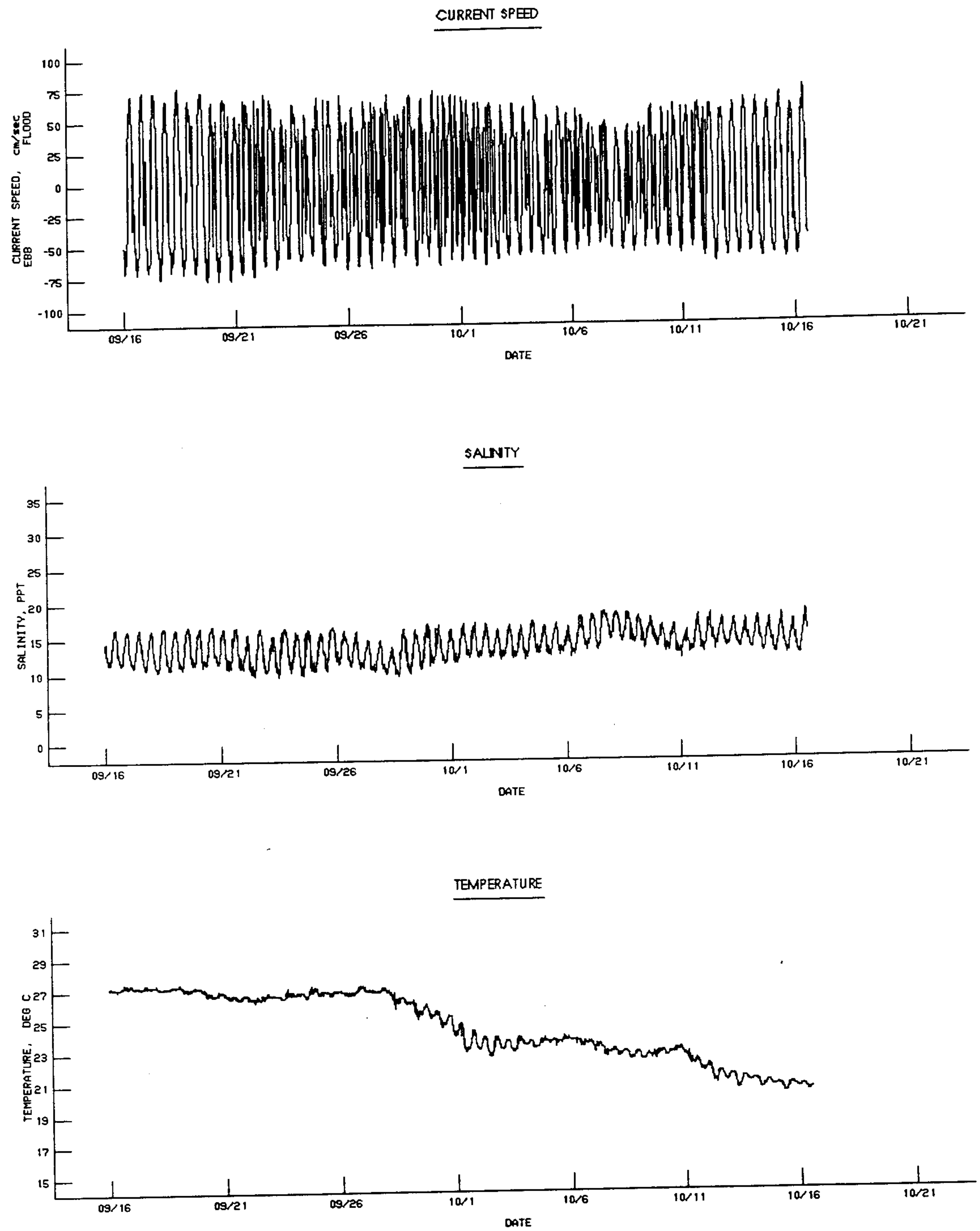


CURRENT SPEED, SALINITY,
AND TEMPERATURE
STA S3.9, NEAR BOTTOM
09/16/93 - 10/18/93

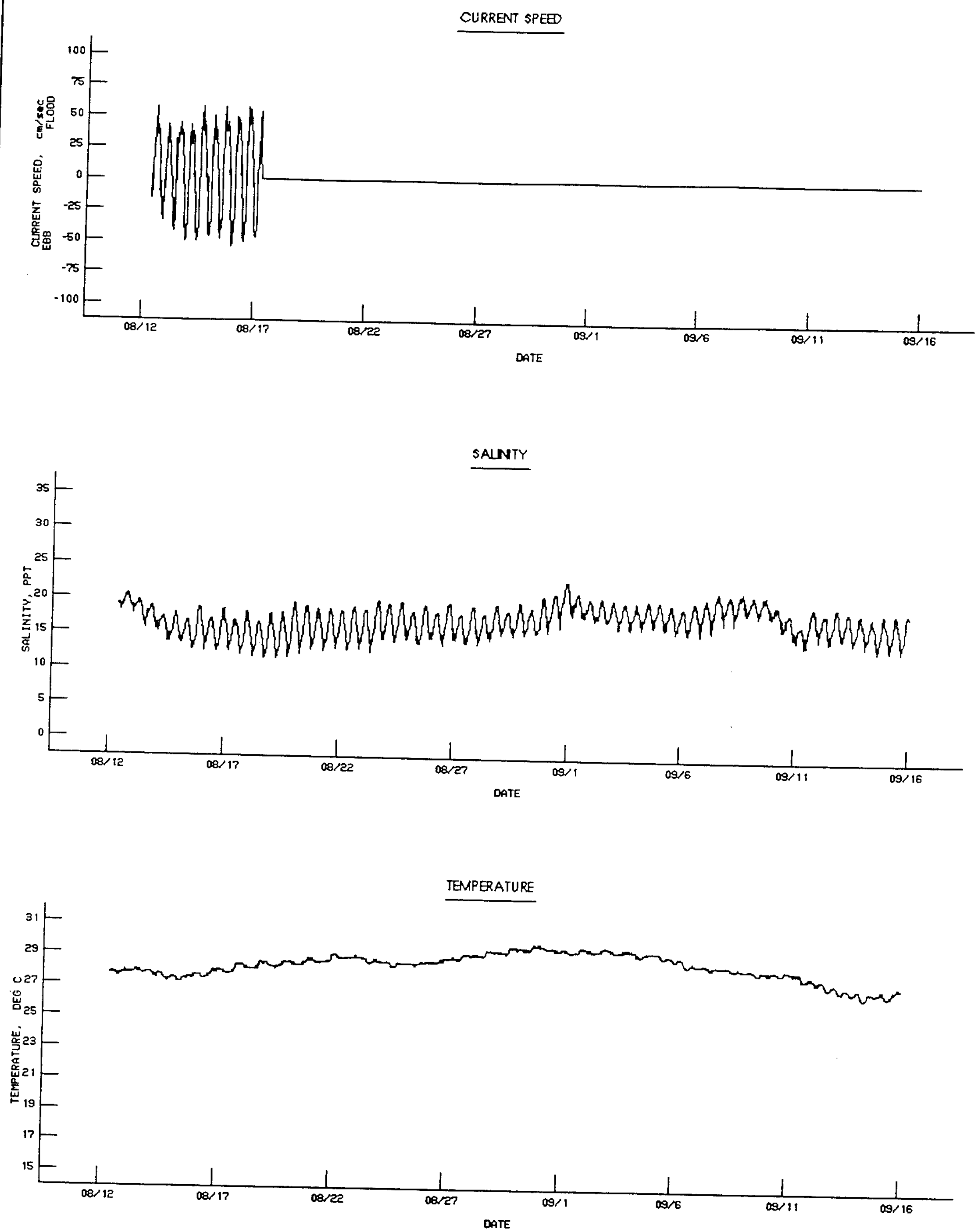


CURRENT SPEED, SALINITY,
AND TEMPERATURE
STATION S5.9, MIDDEPTH
08/12/93 - 09/16/93

Plate 32



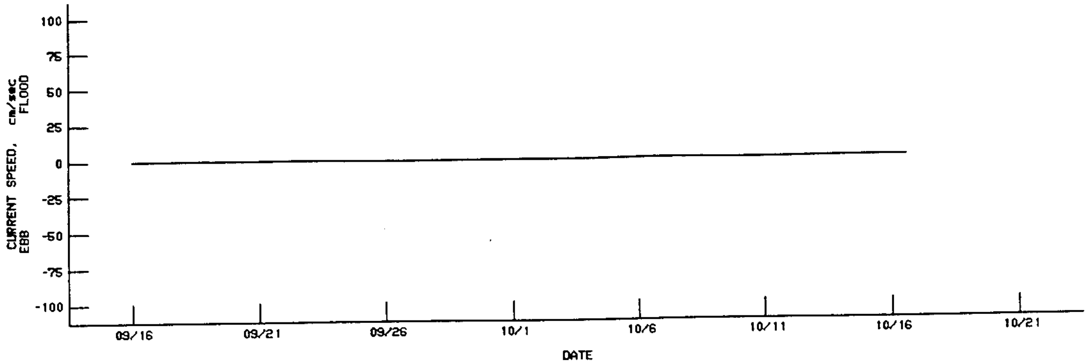
CURRENT SPEED, SALINITY,
AND TEMPERATURE
STATION S5.9, MIDDEPTH
09/16/93 - 10/18/93



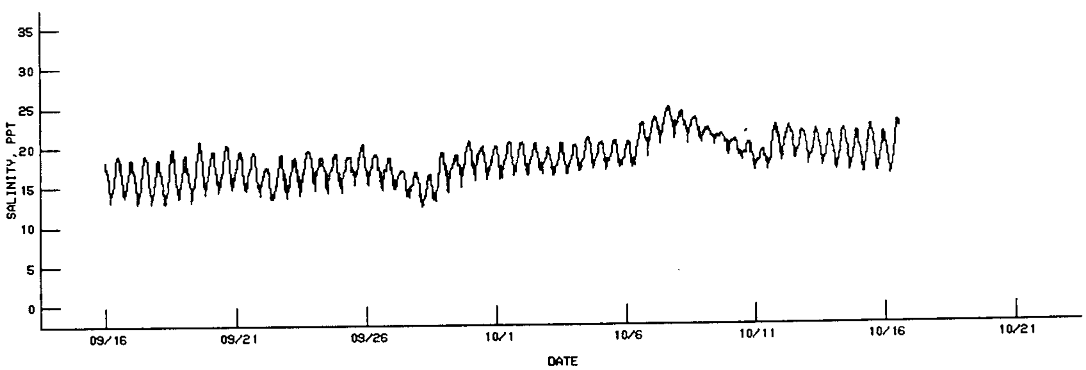
CURRENT SPEED, SALINITY,
AND TEMPERATURE
STA S5.9, NEAR BOTTOM
08/12/93 - 09/16/93

Plate 34

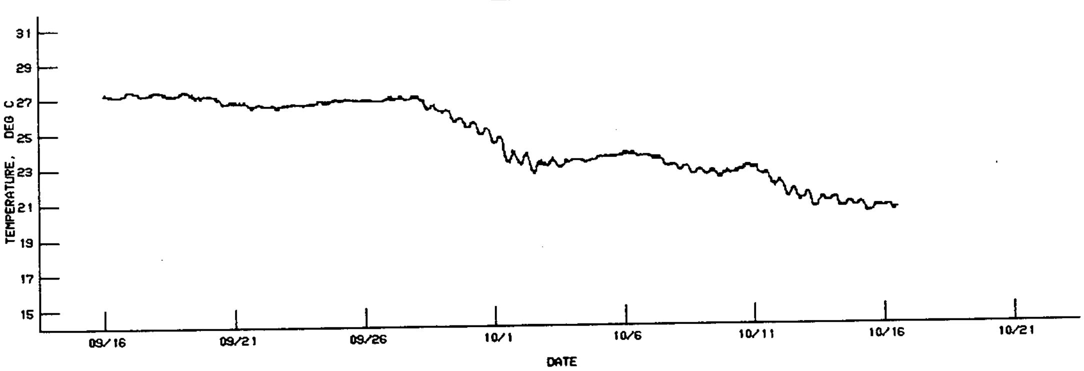
CURRENT SPEED



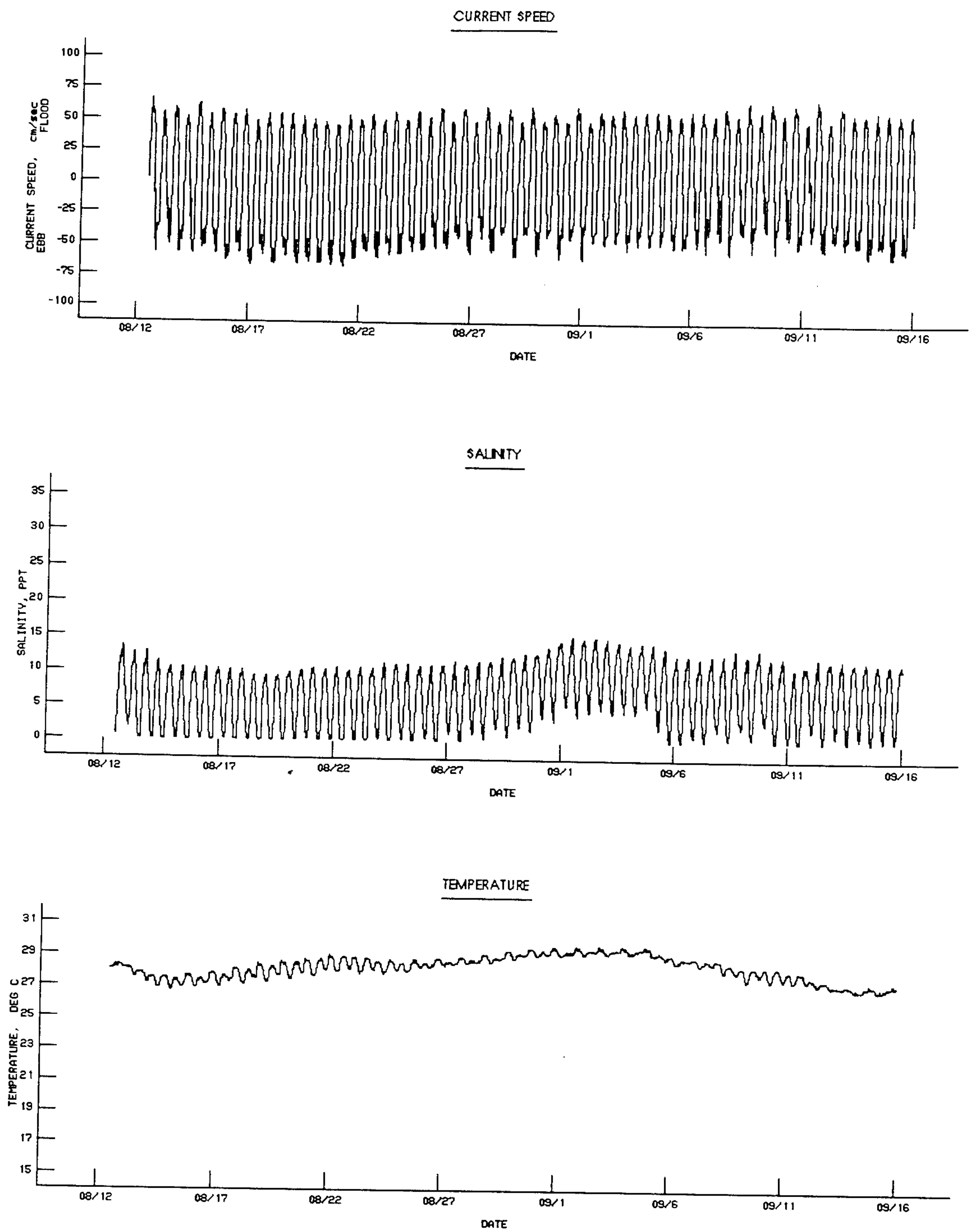
SALINITY



TEMPERATURE



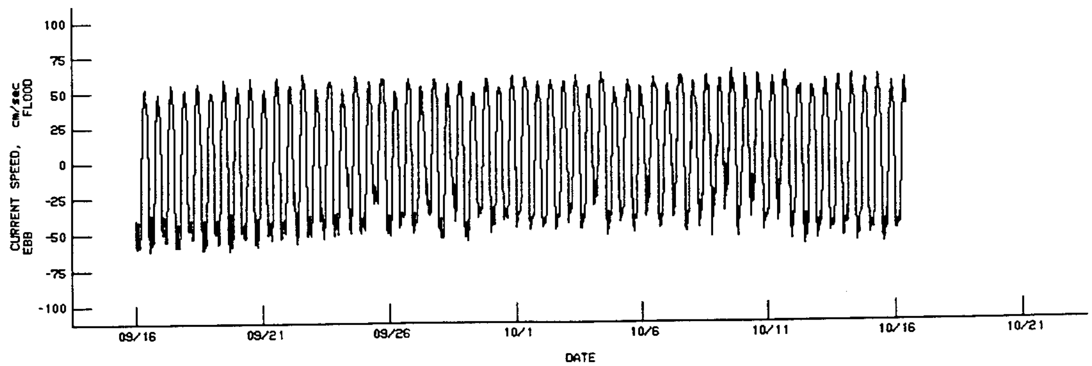
CURRENT SPEED, SALINITY,
AND TEMPERATURE
STA S5.9, NEAR BOTTOM
09/16/93 - 10/18/93



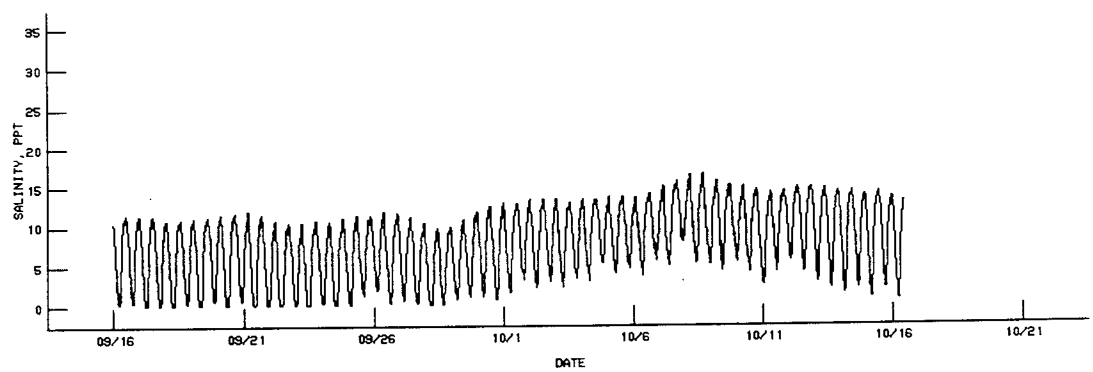
CURRENT SPEED, SALINITY,
AND TEMPERATURE
STATION S6.9, MIDDEPTH
08/12/93 - 09/16/93

Plate 36

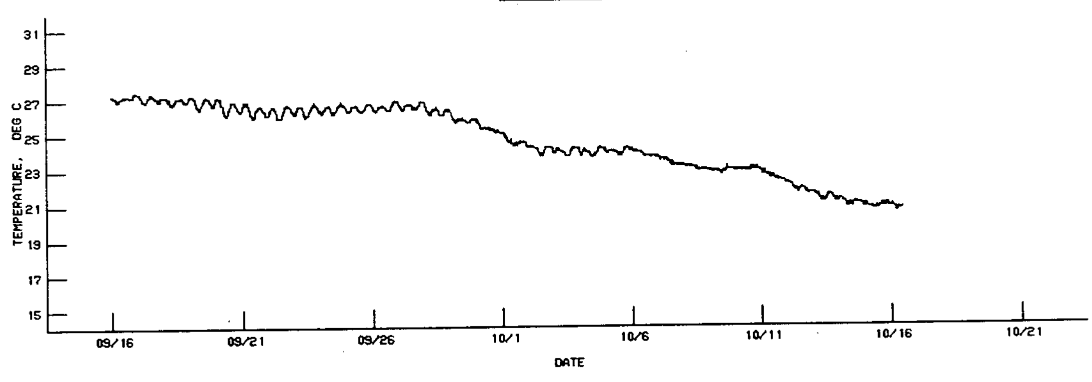
CURRENT SPEED



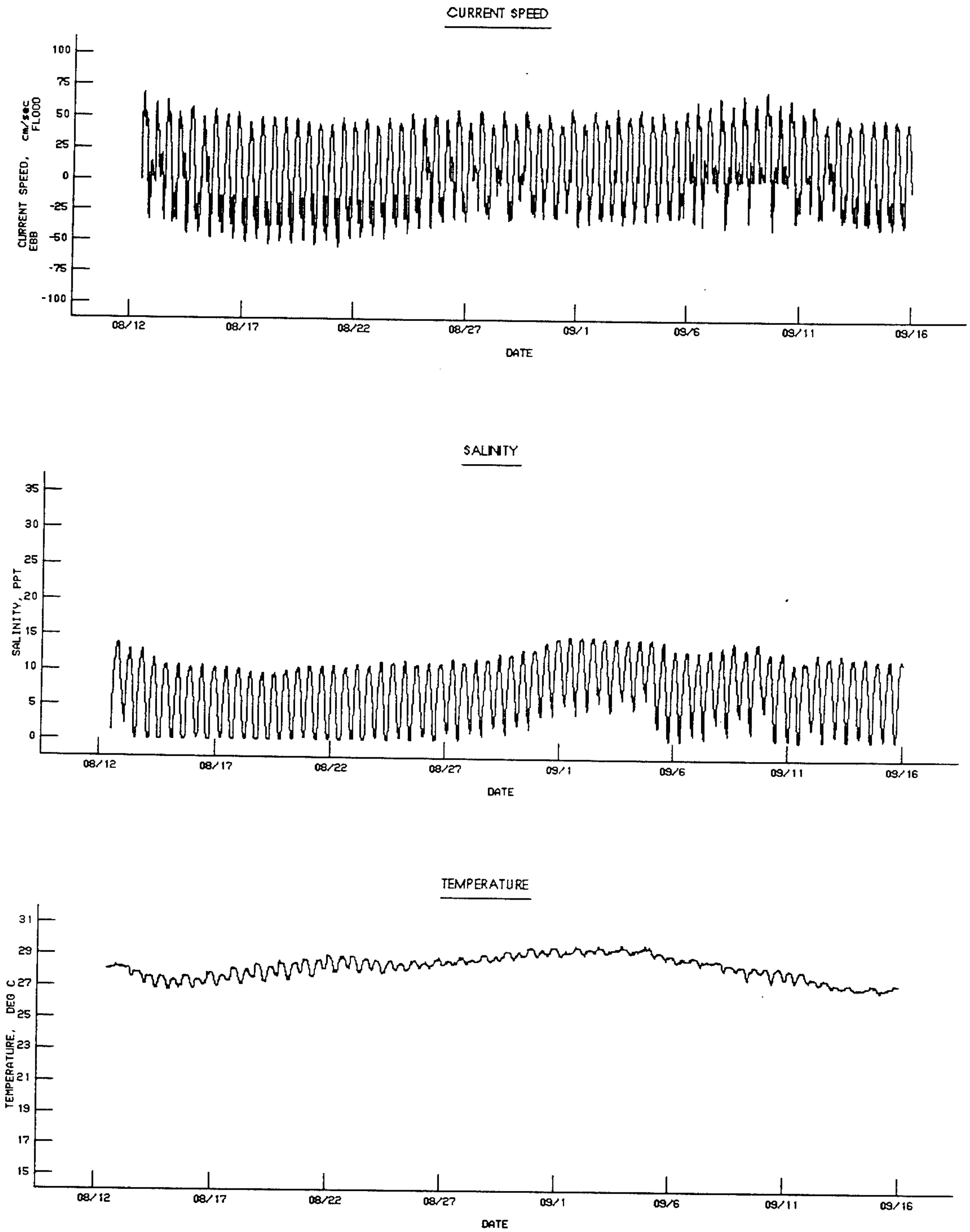
SALINITY



TEMPERATURE

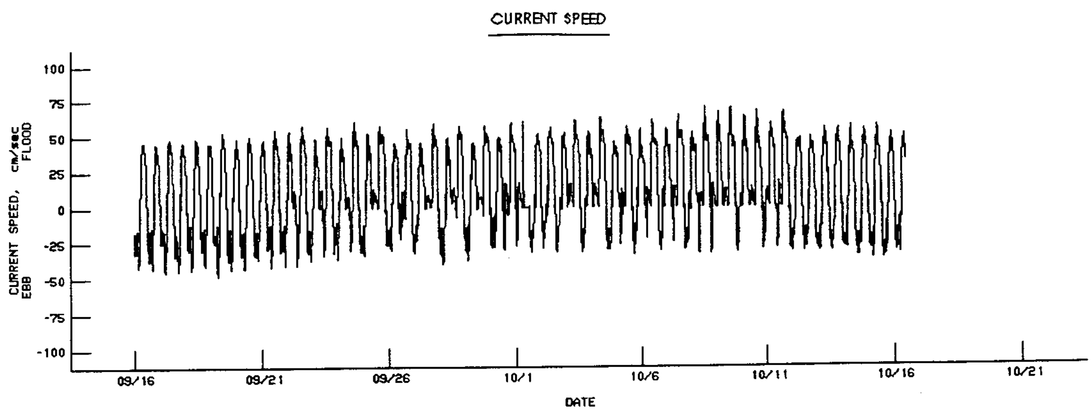


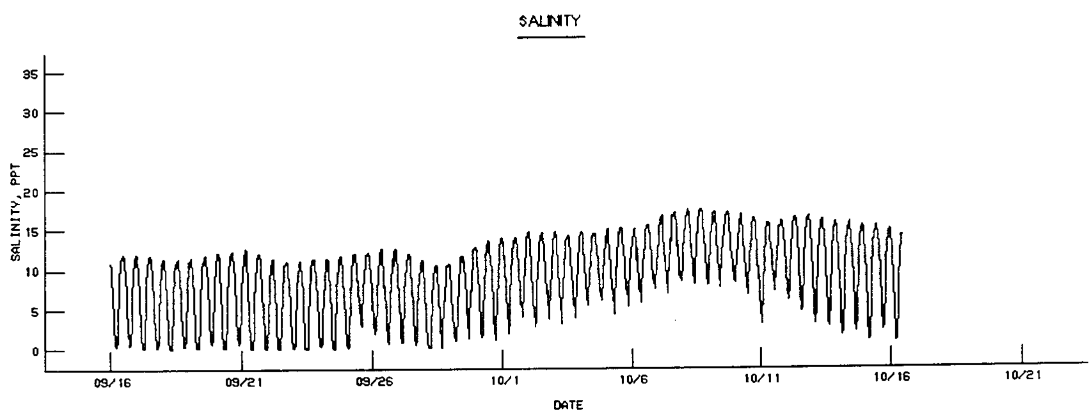
CURRENT SPEED, SALINITY, AND TEMPERATURE STATION S6.9, MIDDEPTH 09/16/93 - 10/18/93

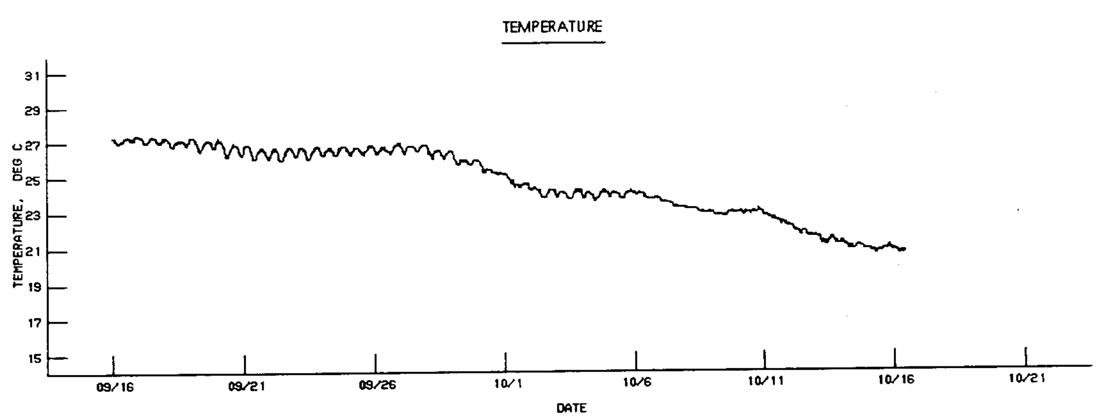


CURRENT SPEED, SALINITY,
AND TEMPERATURE
STA S6.9, NEAR BOTTOM
08/12/93 - 09/16/93

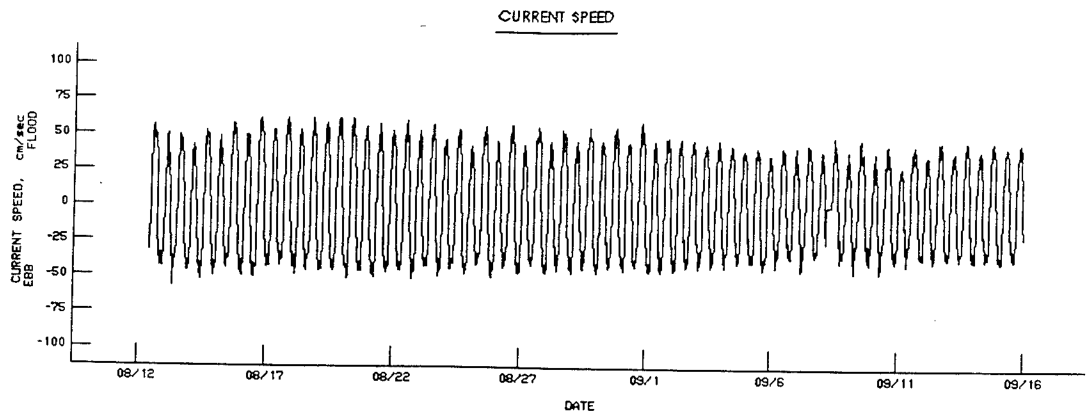
Plate 38

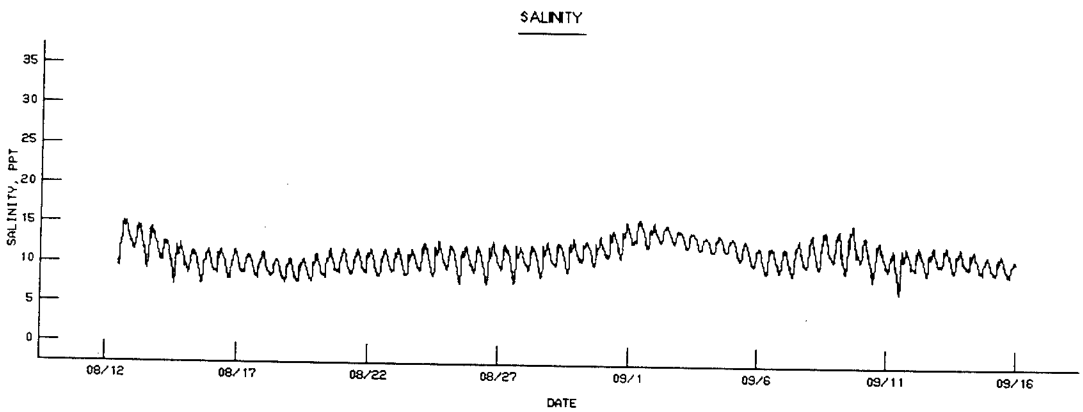


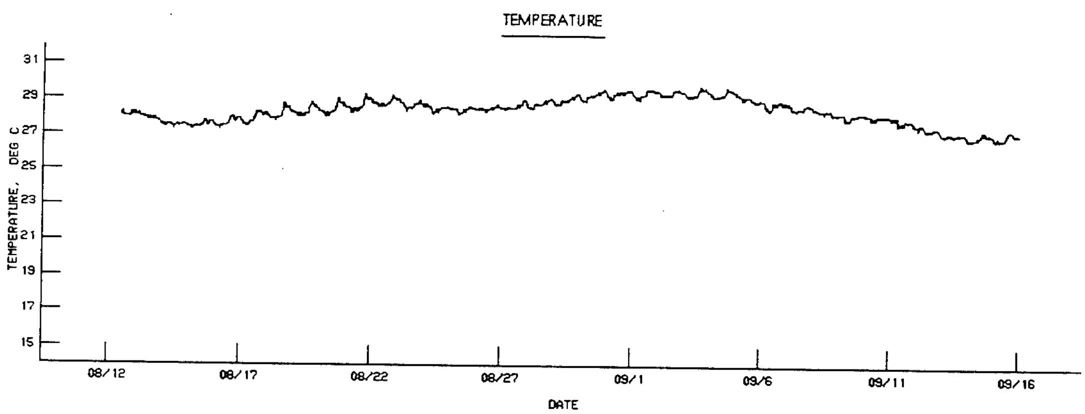




CURRENT SPEED, SALINITY,
AND TEMPERATURE
STA S6.9, NEAR BOTTOM
09/16/93 - 10/18/93

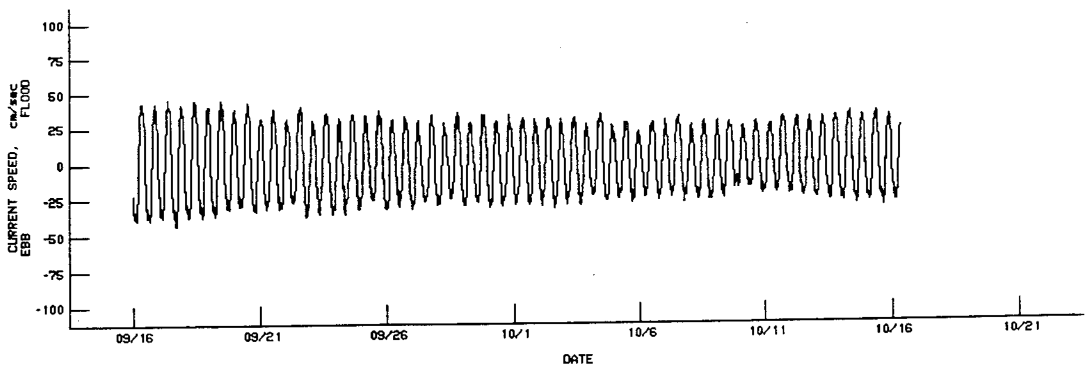




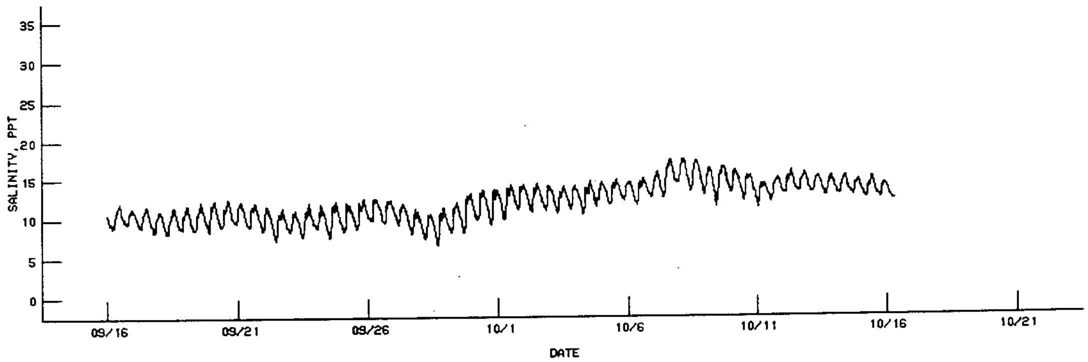


CURRENT SPEED, SALINITY,
AND TEMPERATURE
STATION S7.9, MIDDEPTH
08/12/93 - 09/16/93

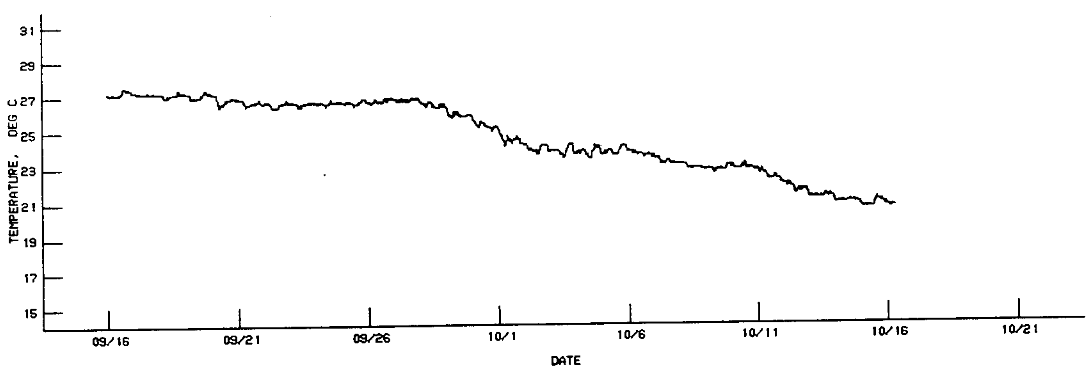
CURRENT SPEED



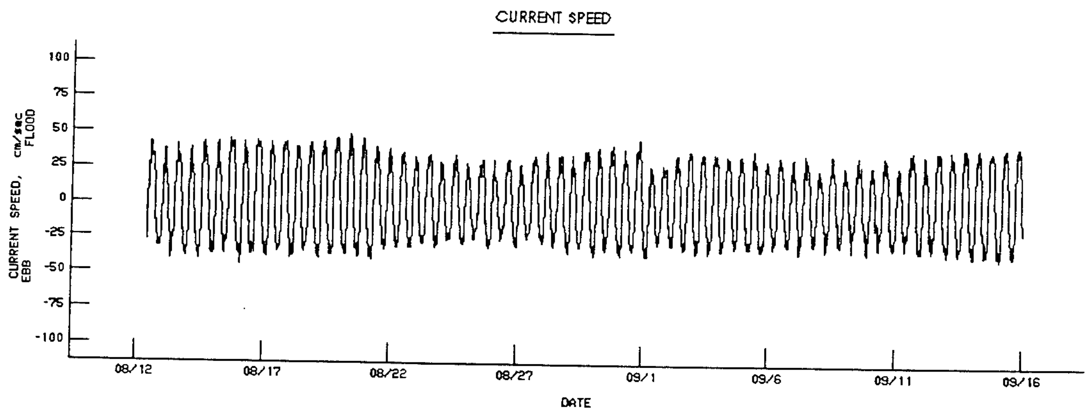
SALINITY

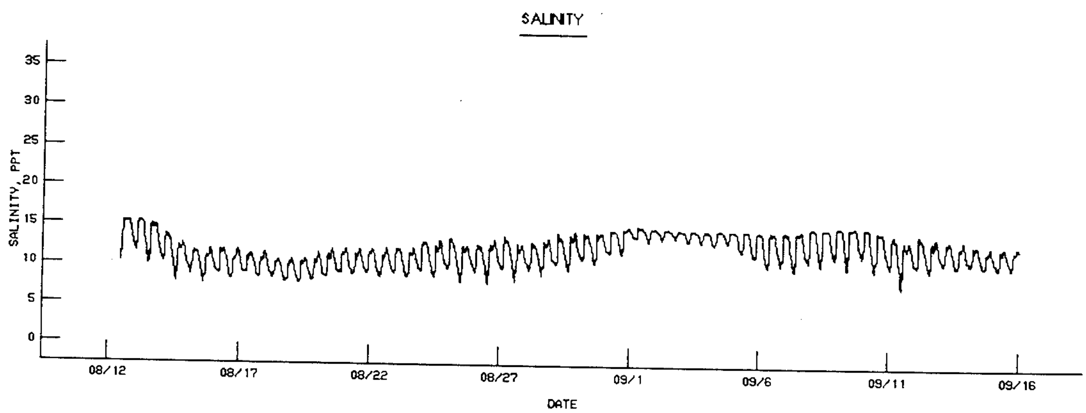


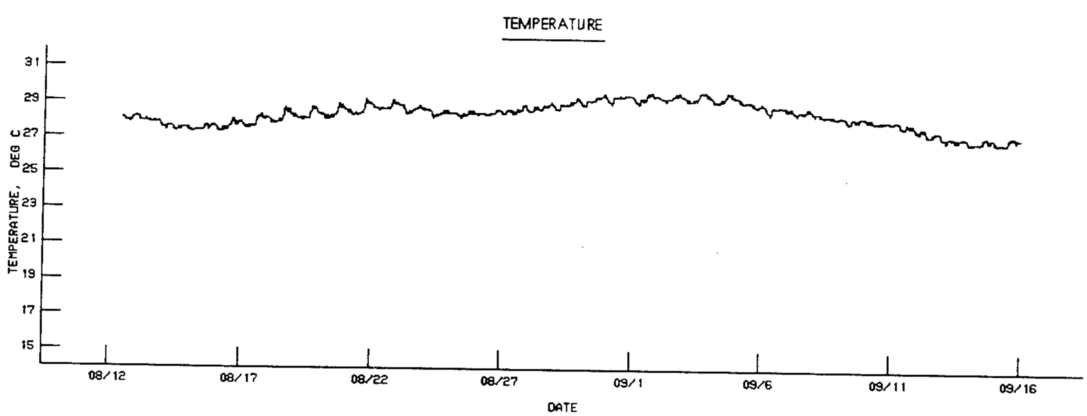
TEMPERATURE



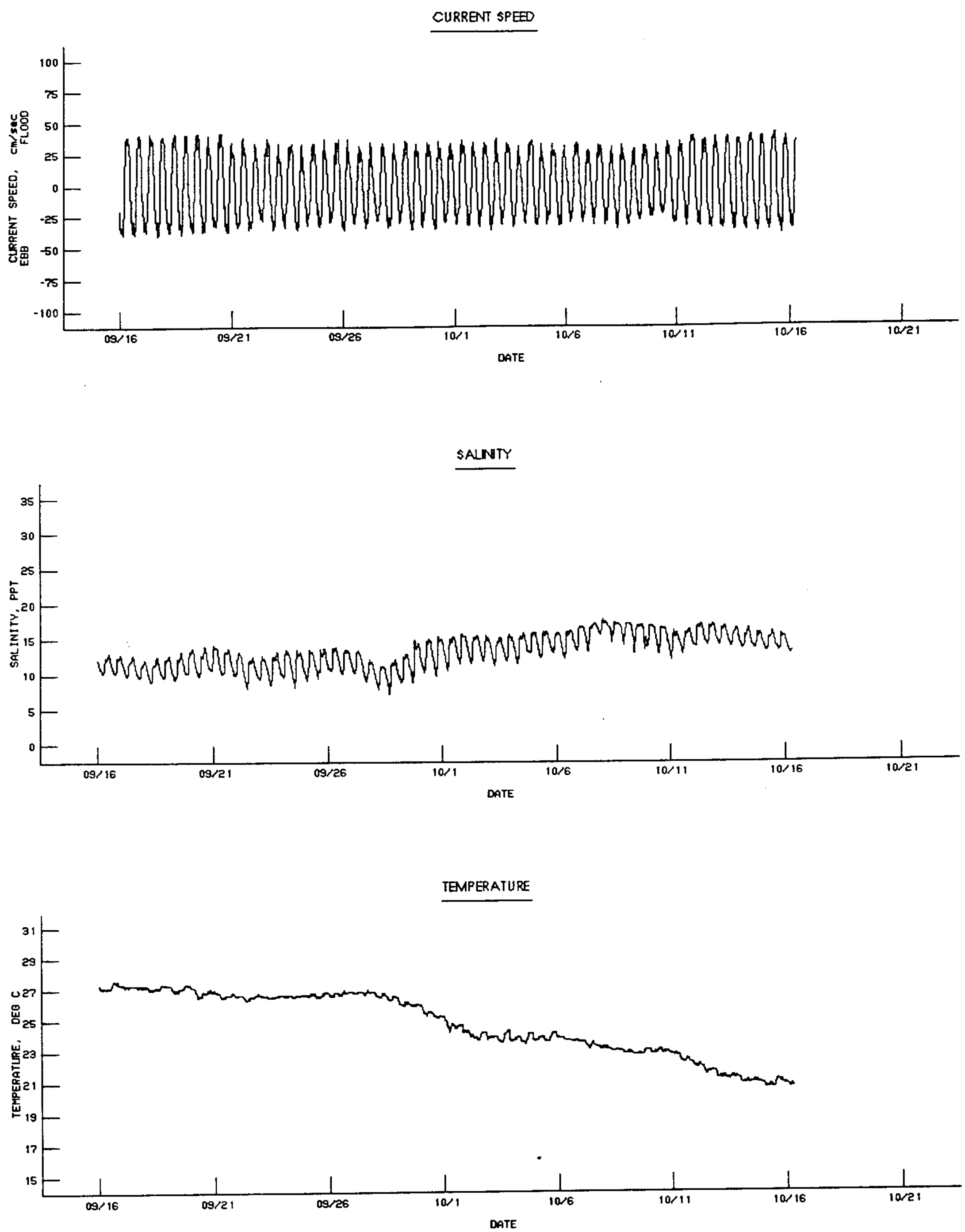
CURRENT SPEED, SALINITY,
AND TEMPERATURE
STATION S7.9, MIDDEPTH
09/16/93 - 10/18/93



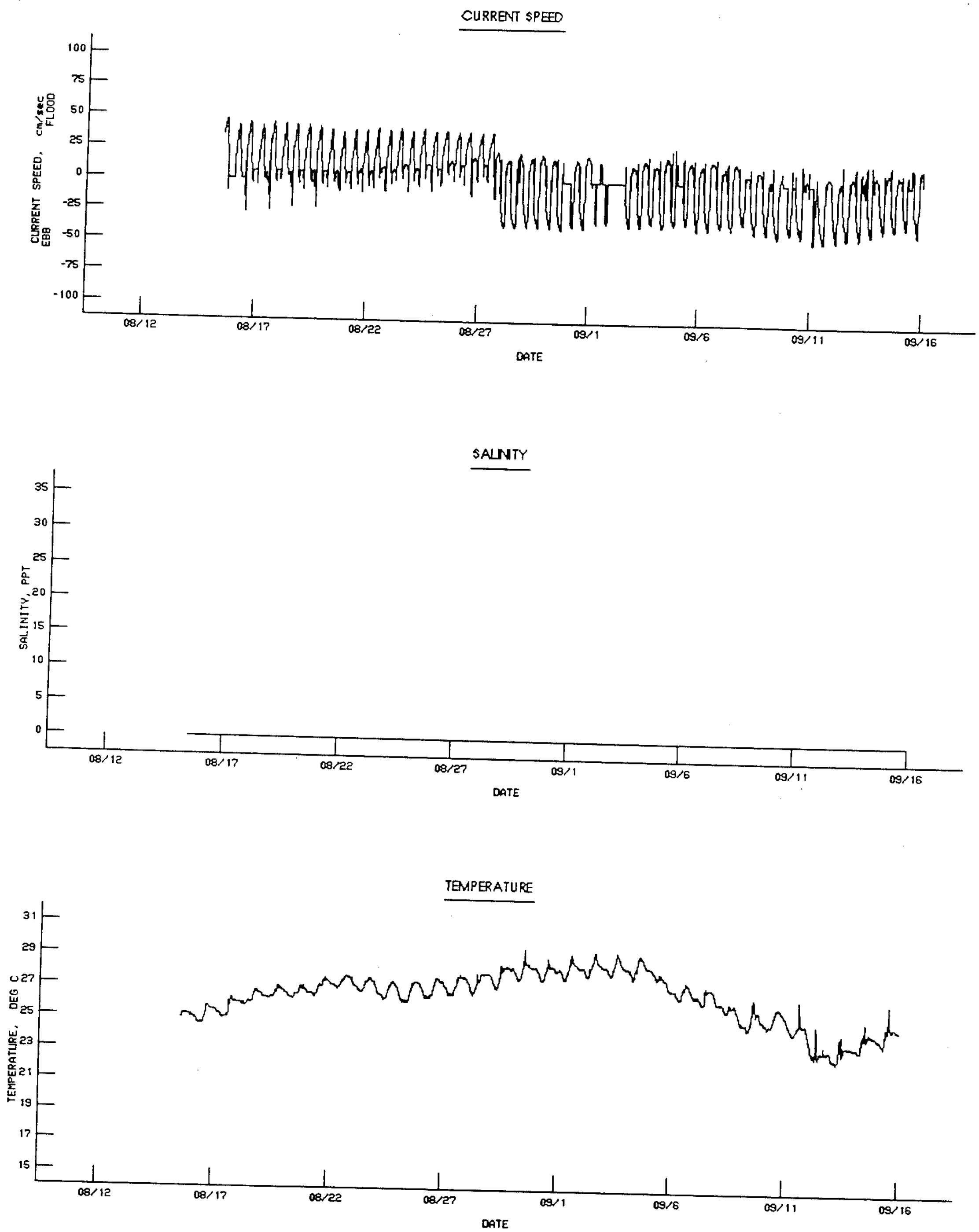




CURRENT SPEED, SALINITY,
AND TEMPERATURE
STA S7.9, NEAR BOTTOM
08/12/93 - 09/16/93

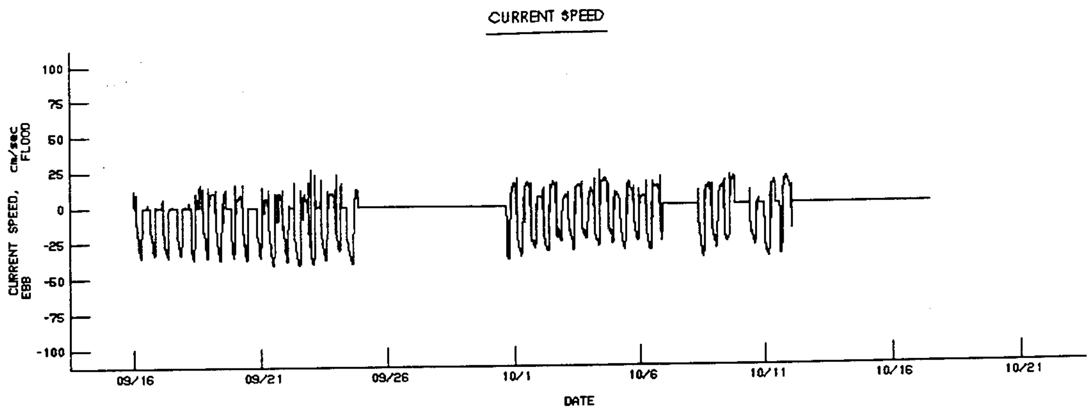


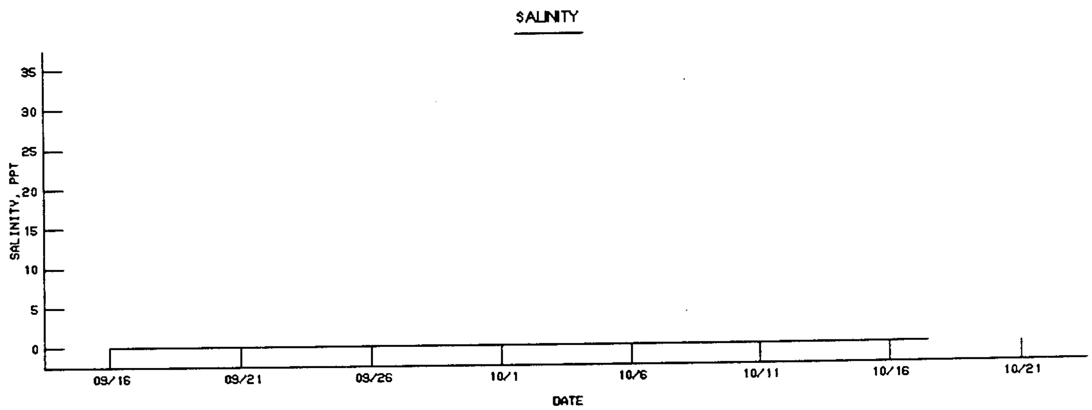
CURRENT SPEED, SALINITY,
AND TEMPERATURE
STA S7.9, NEAR BOTTOM
09/16/93 - 10/18/93

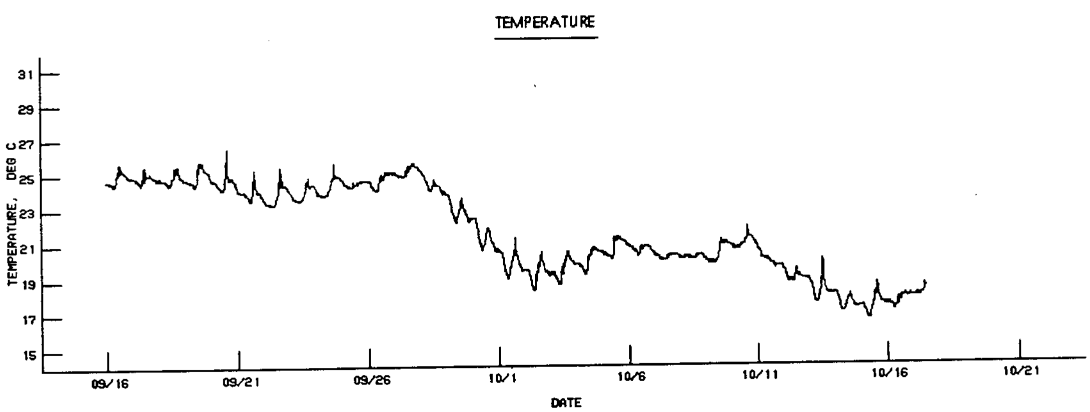


CURRENT SPEED, SALINITY,
AND TEMPERATURE
STATION S9.9, MIDDEPTH
08/12/93 - 09/16/93

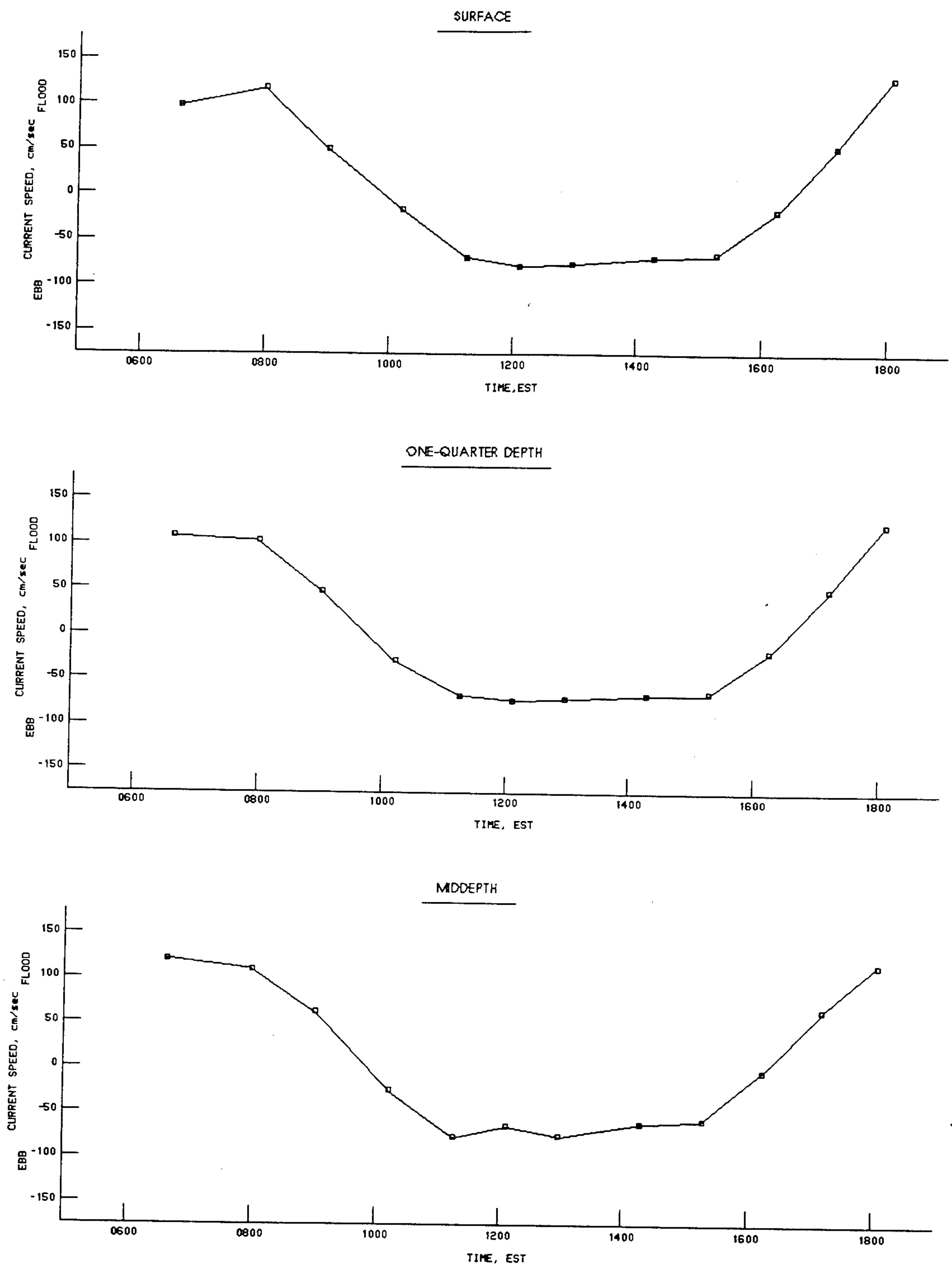
Plate 44



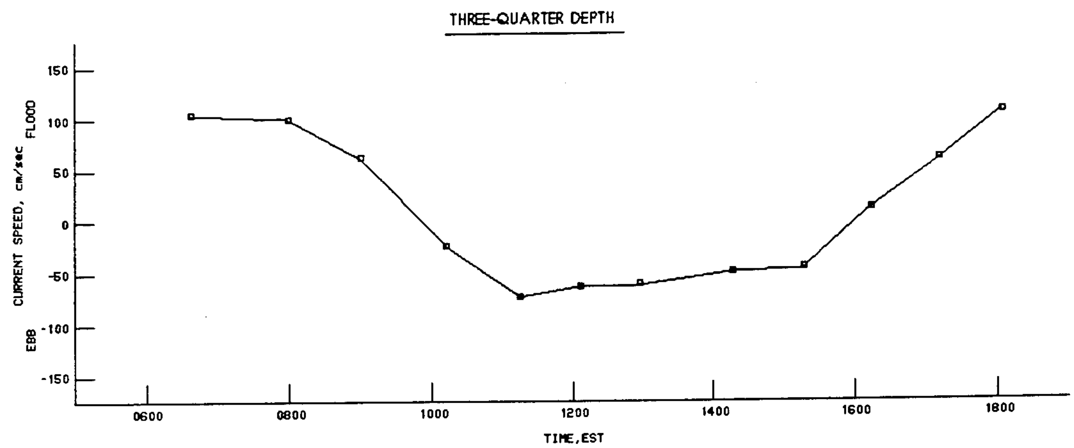


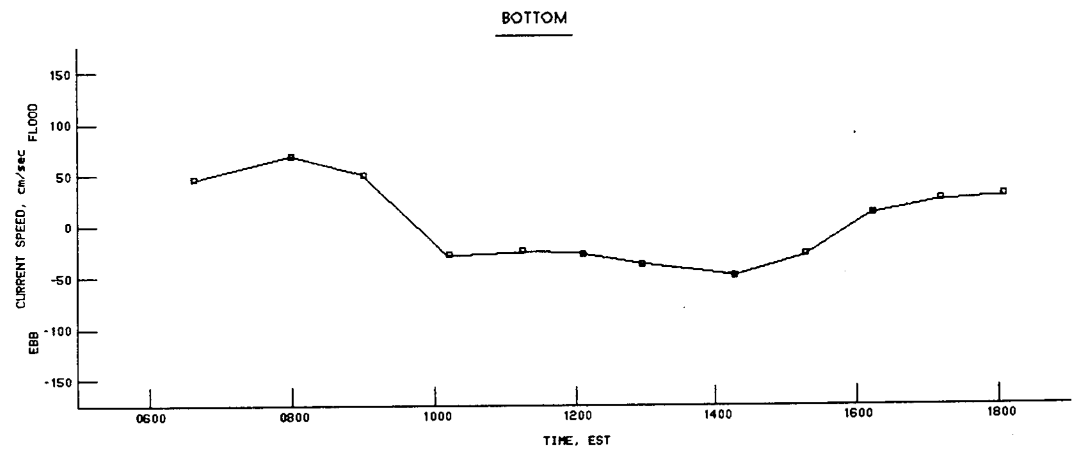


CURRENT SPEED, SALINITY,
AND TEMPERATURE
STATION S9.9, MIDDEPTH
09/16/93 - 10/18/93

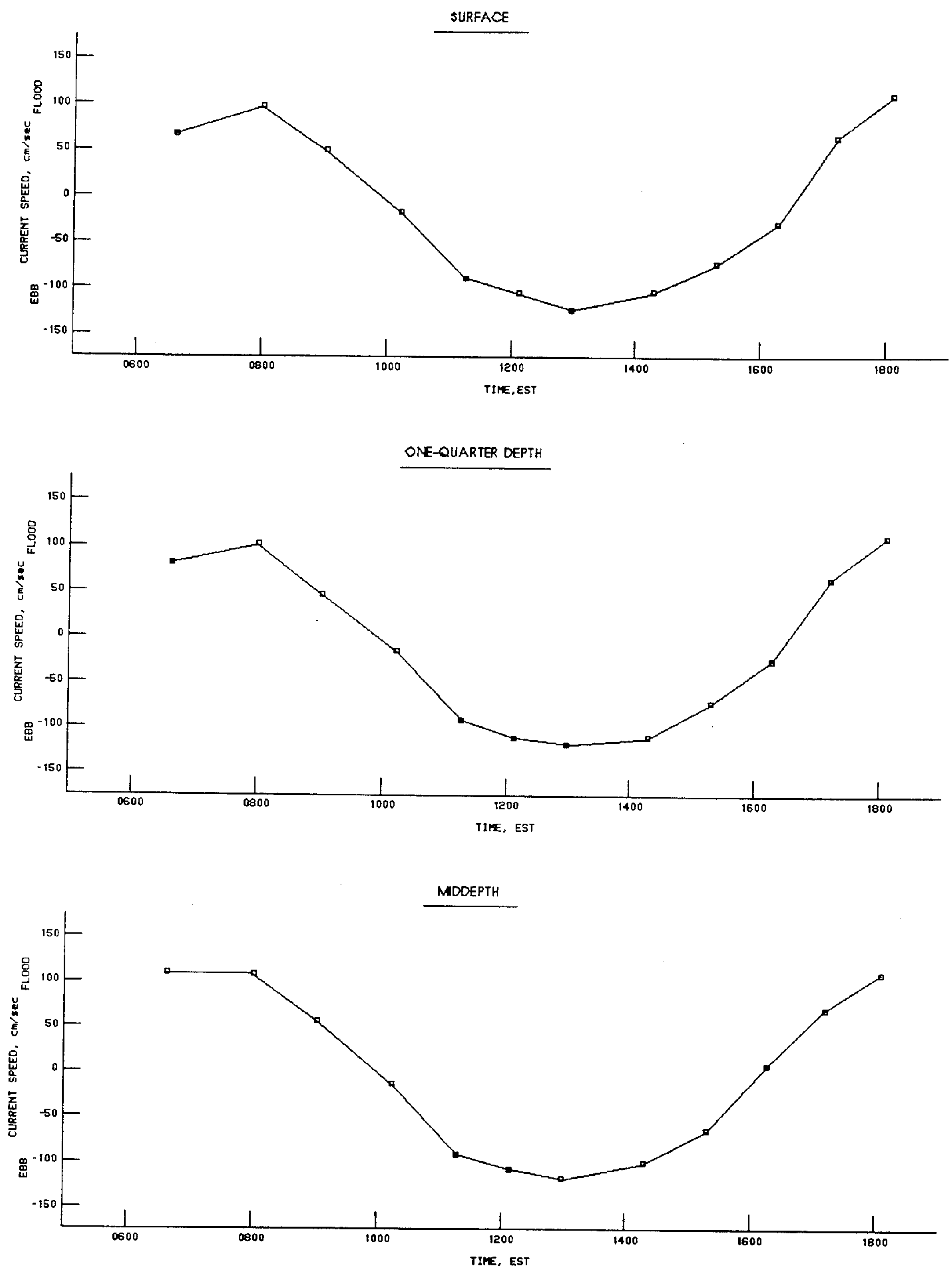


CURRENT SPEED
STATION R1.0 (400)
SURFACE, ONE-QUARTER DEPTH, AND MIDDEPTH
08/19/93

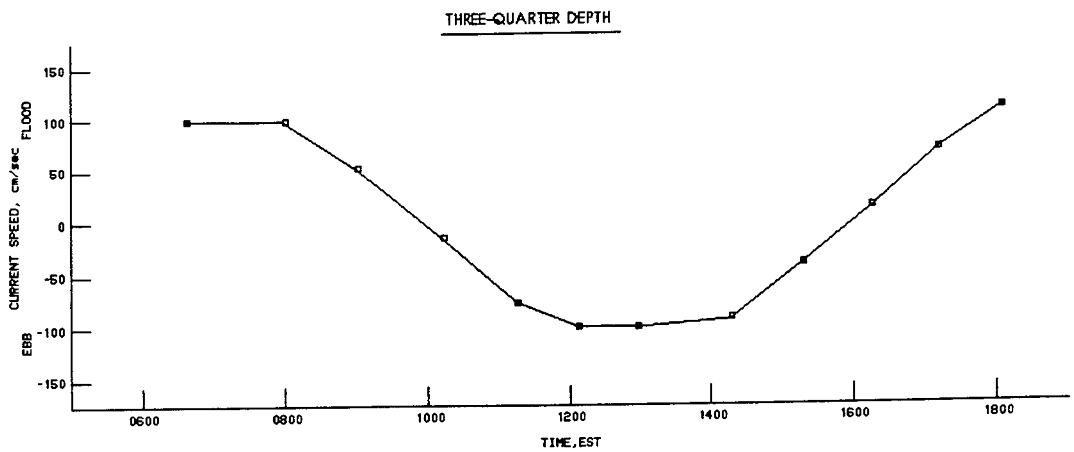


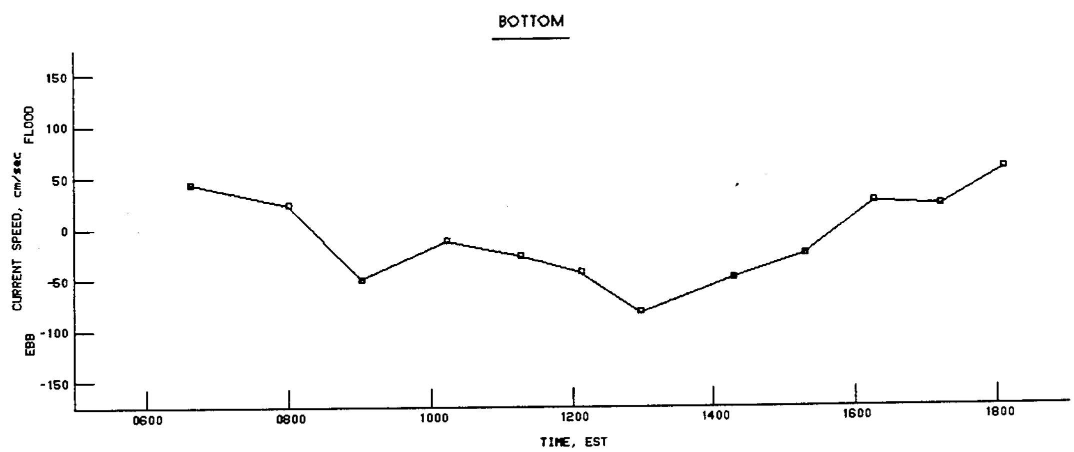


CURRENT SPEED
STATION R1.0 (400)
THREE-QUARTER DEPTH AND BOTTOM
08/19/93

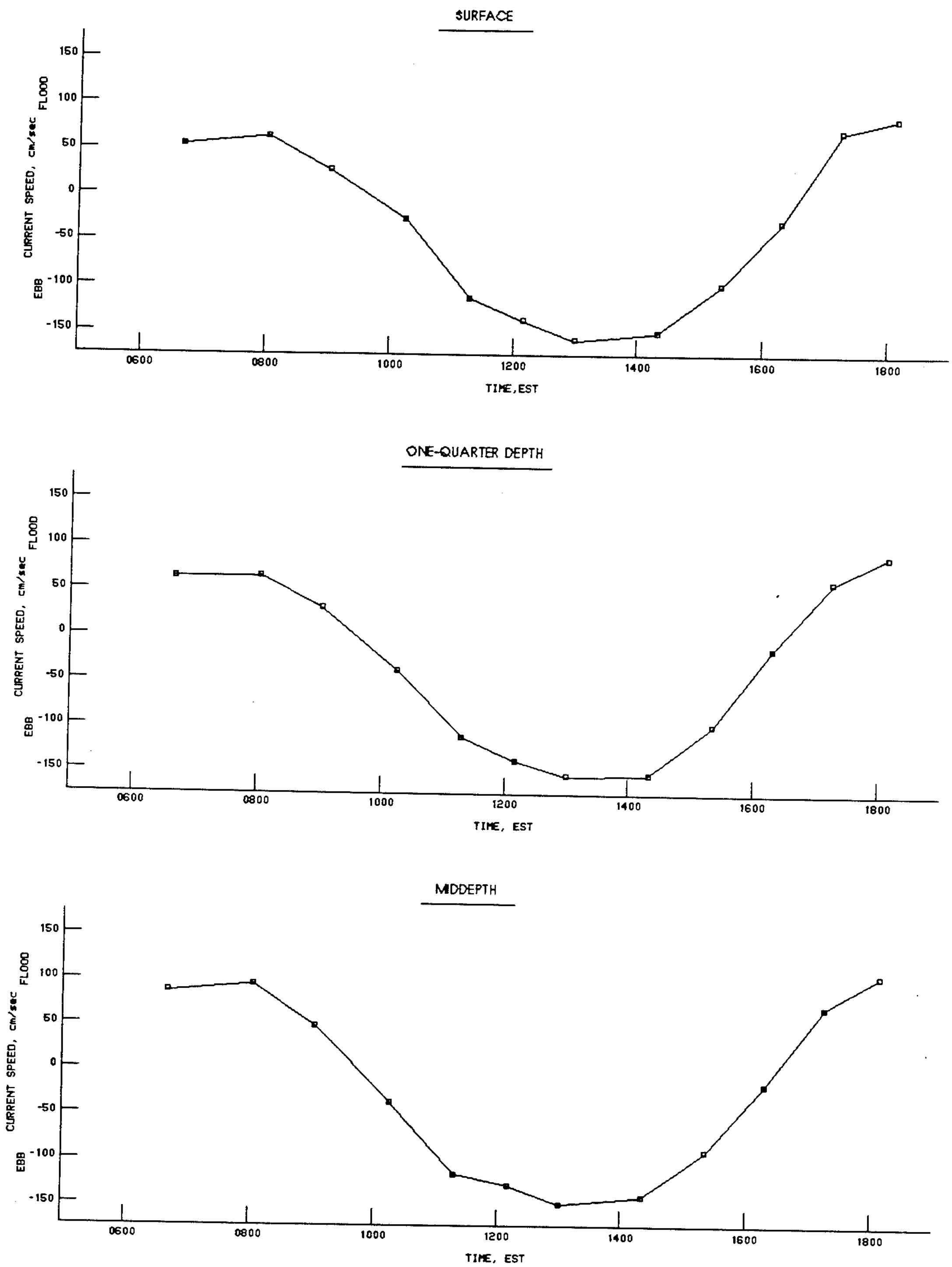


CURRENT SPEED
STATION R1.0 (800)
SURFACE, ONE-QUARTER DEPTH, AND MIDDEPTH
08/19/93



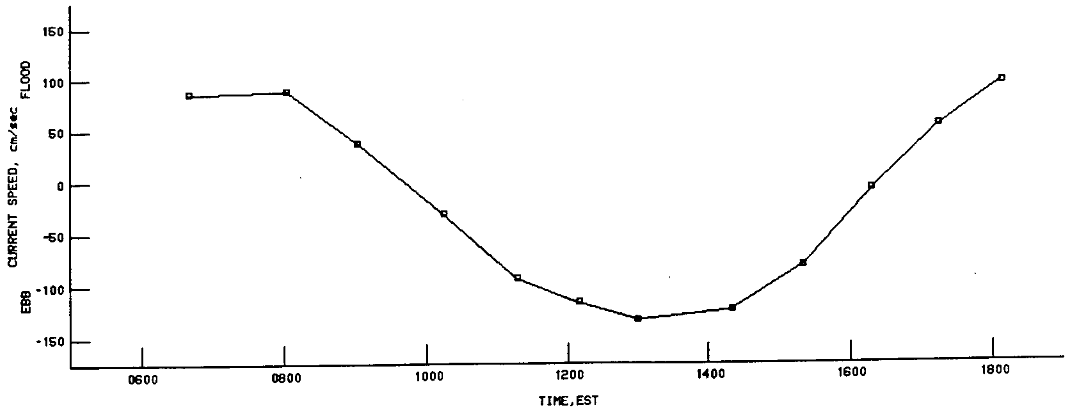


CURRENT SPEED
STATION R1.0 (800)
THREE-QUARTER DEPTH AND BOTTOM
08/19/93

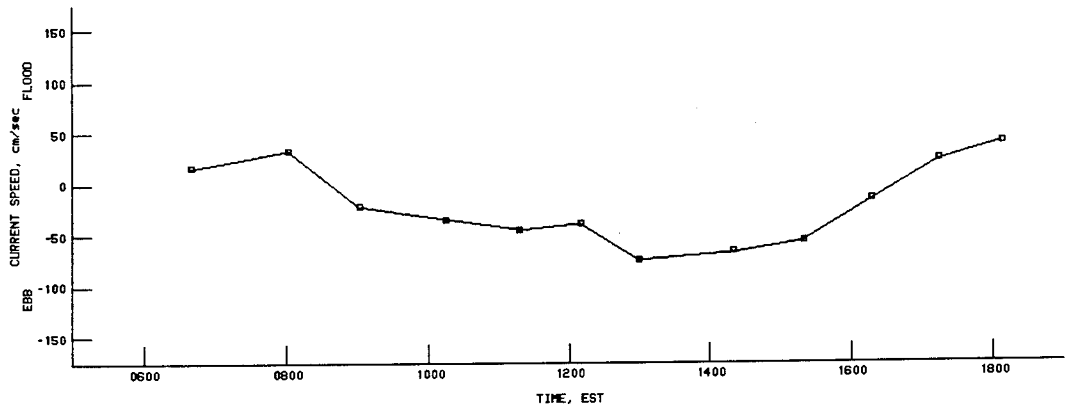


CURRENT SPEED
STATION R1.0 (1200)
SURFACE, ONE-QUARTER DEPTH, AND MIDDEPTH
08/19/93

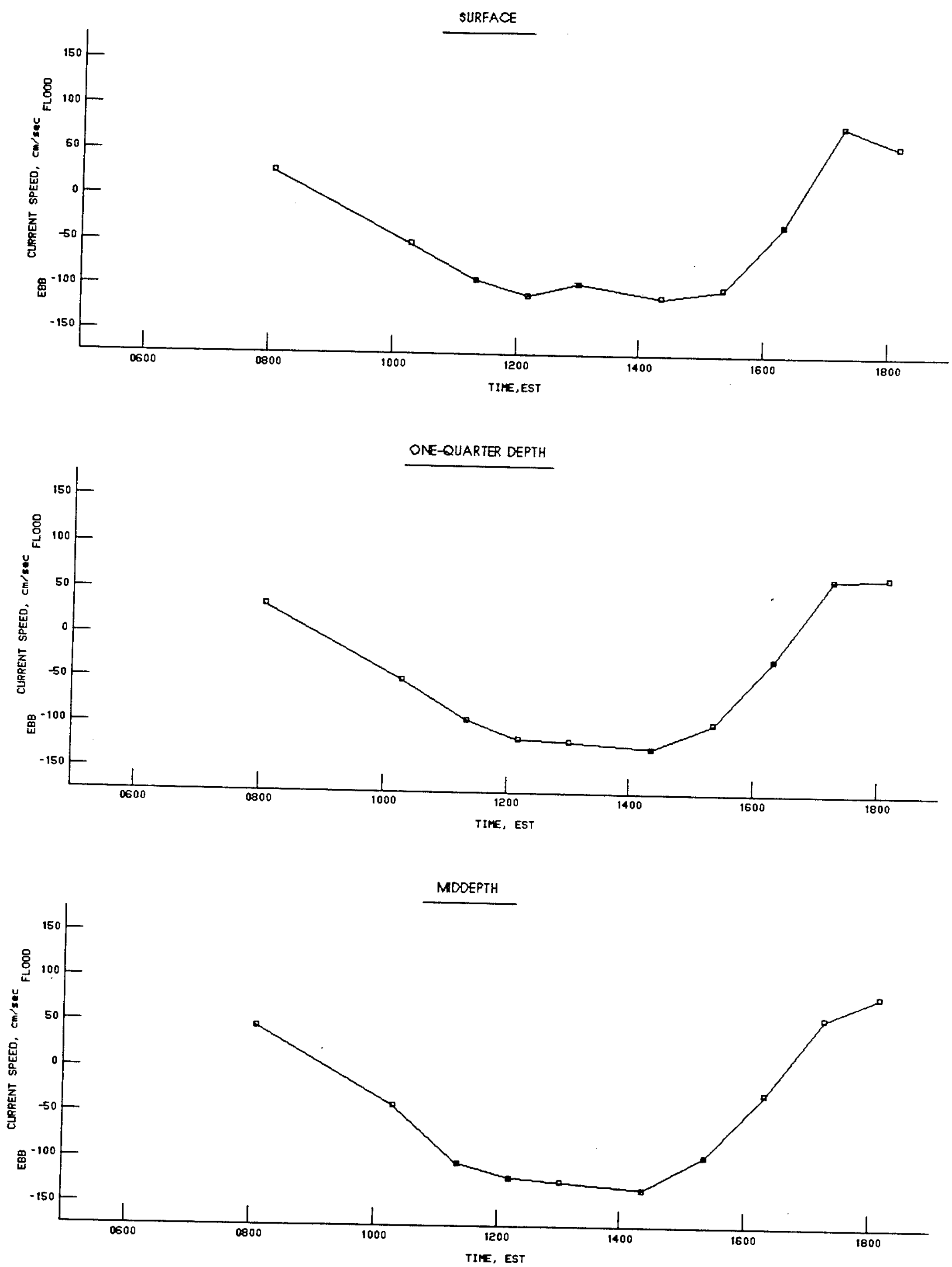
THREE-QUARTER DEPTH



BOTTOM

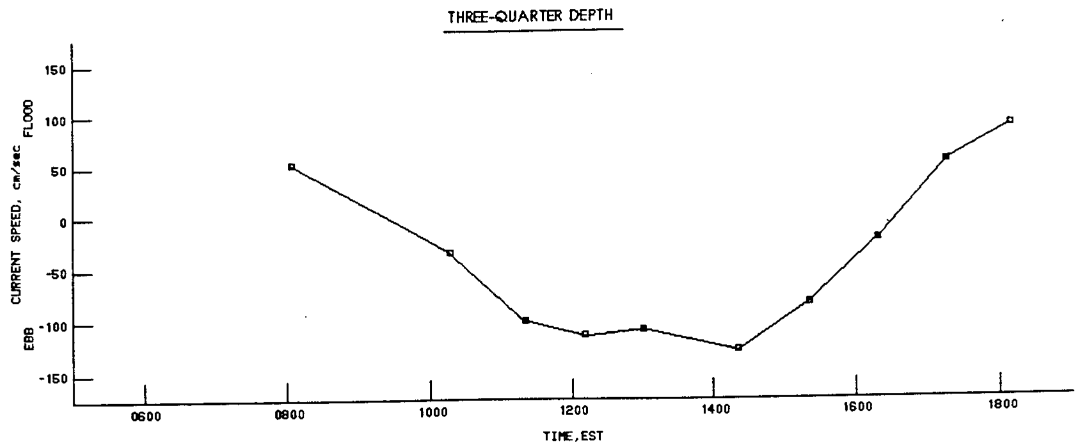


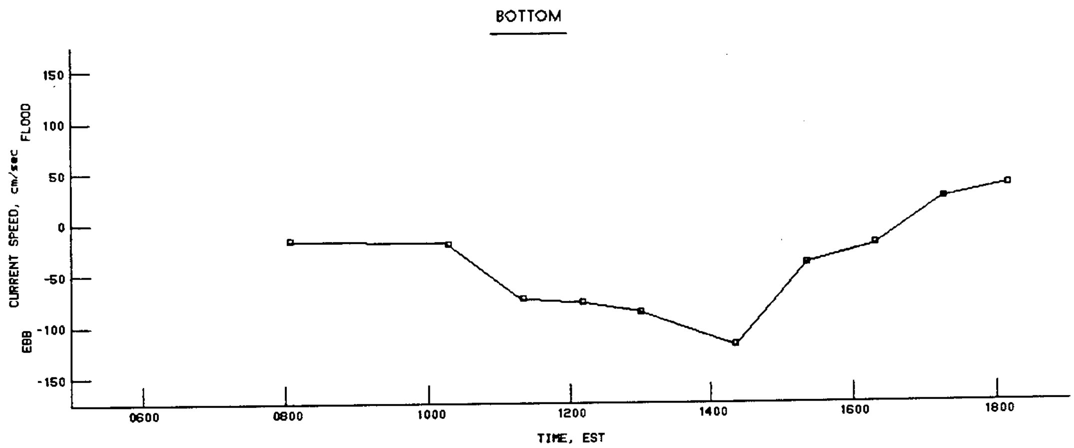
CURRENT SPEED
STATION R1.0 (1200)
THREE-QUARTER DEPTH AND BOTTOM
08/19/93



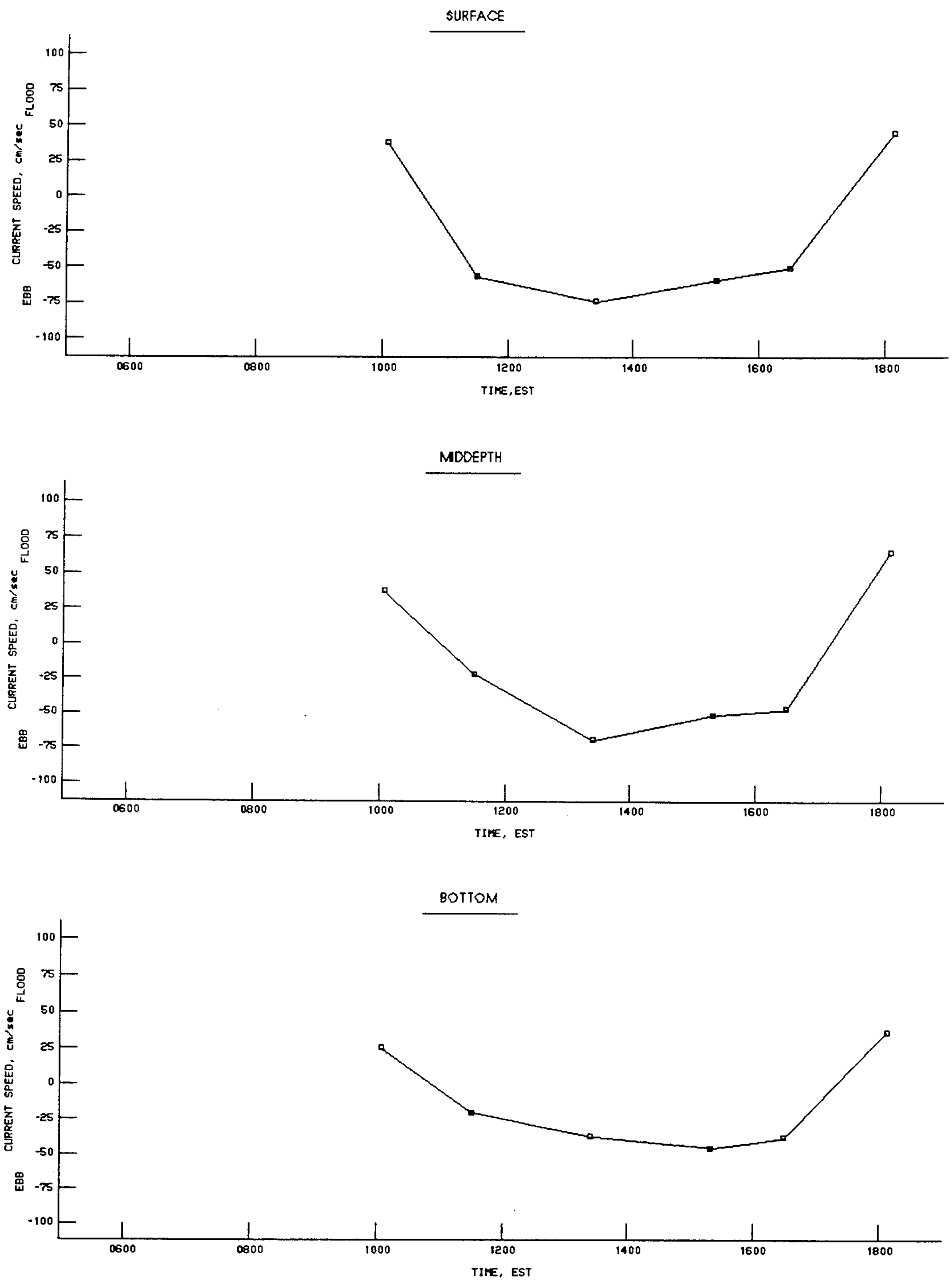
CURRENT SPEED
STATION R1.0 (1600)
SURFACE, ONE-QUARTER DEPTH, AND MIDDEPTH
08/19/93

Plate 52

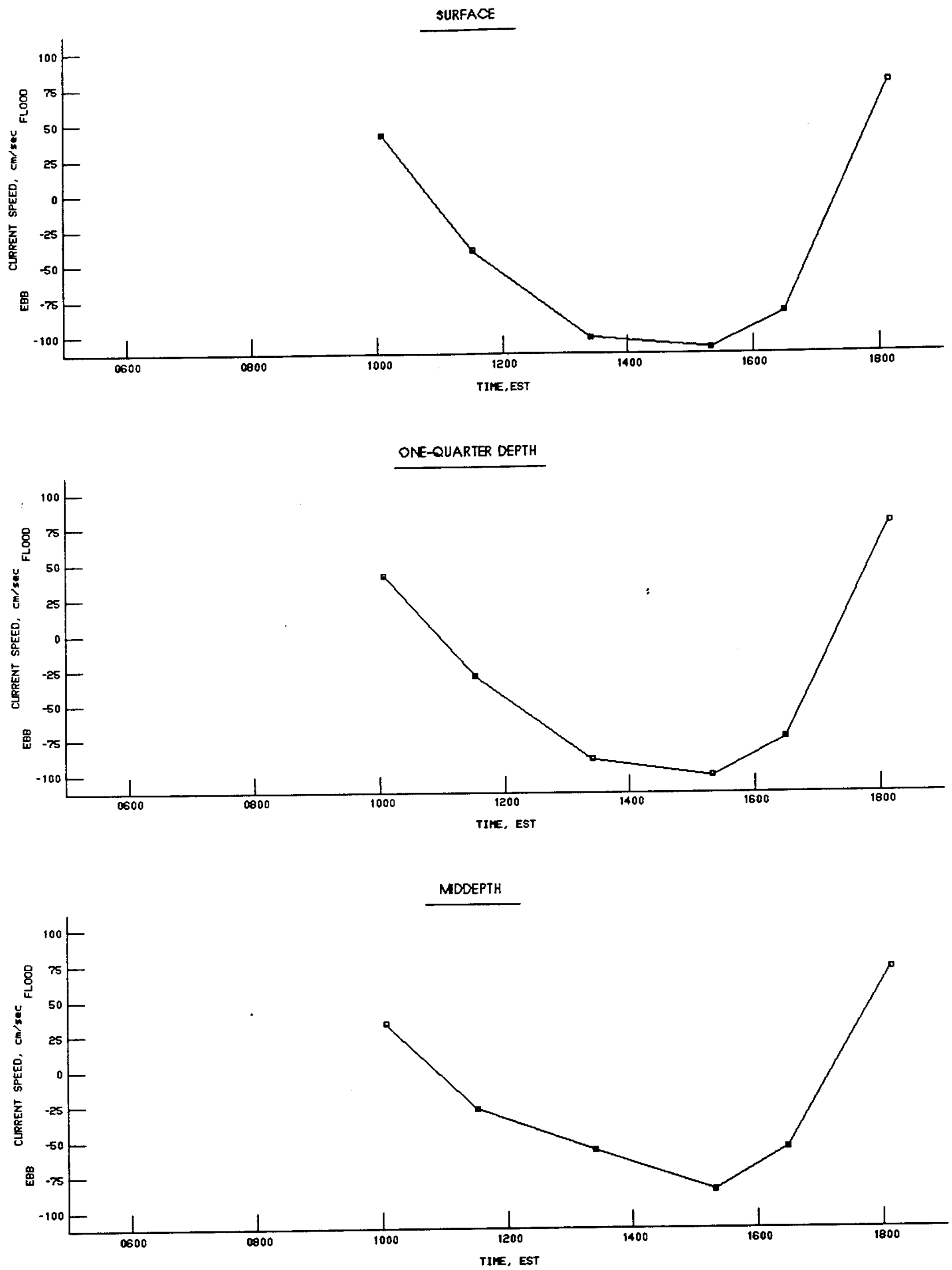




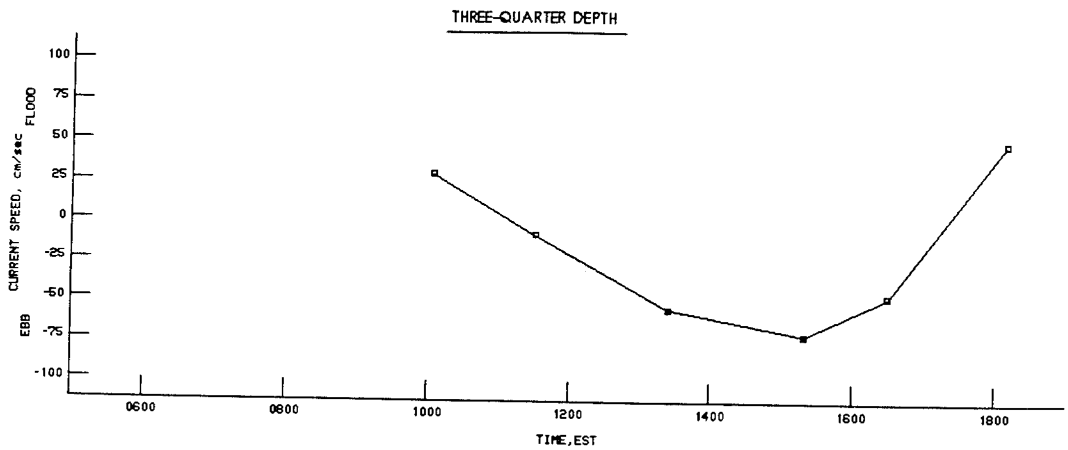
CURRENT SPEED
STATION R1.0 (1600)
THREE-QUARTER DEPTH AND BOTTOM
08/19/93

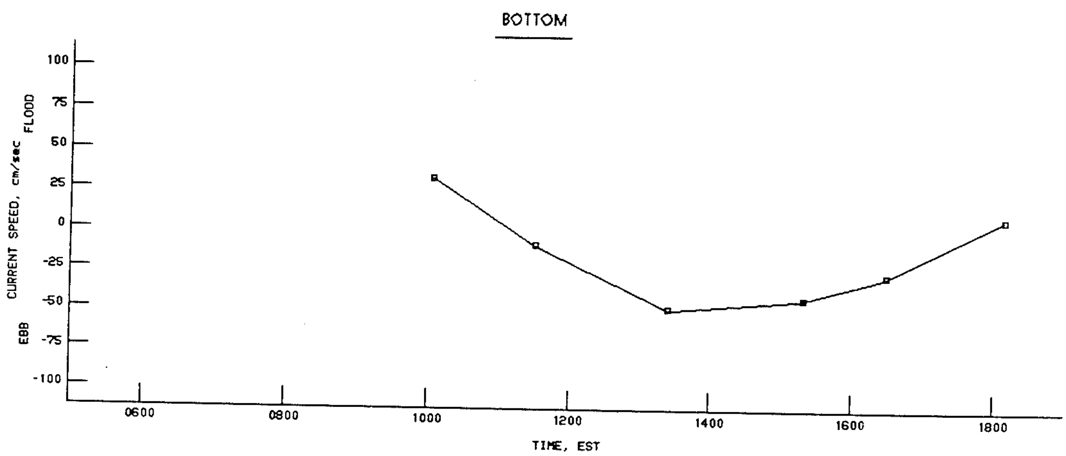


CURRENT SPEED
STATION R3.1 (300)
SURFACE, MIDDEPTH, AND BOTTOM
08/19/93



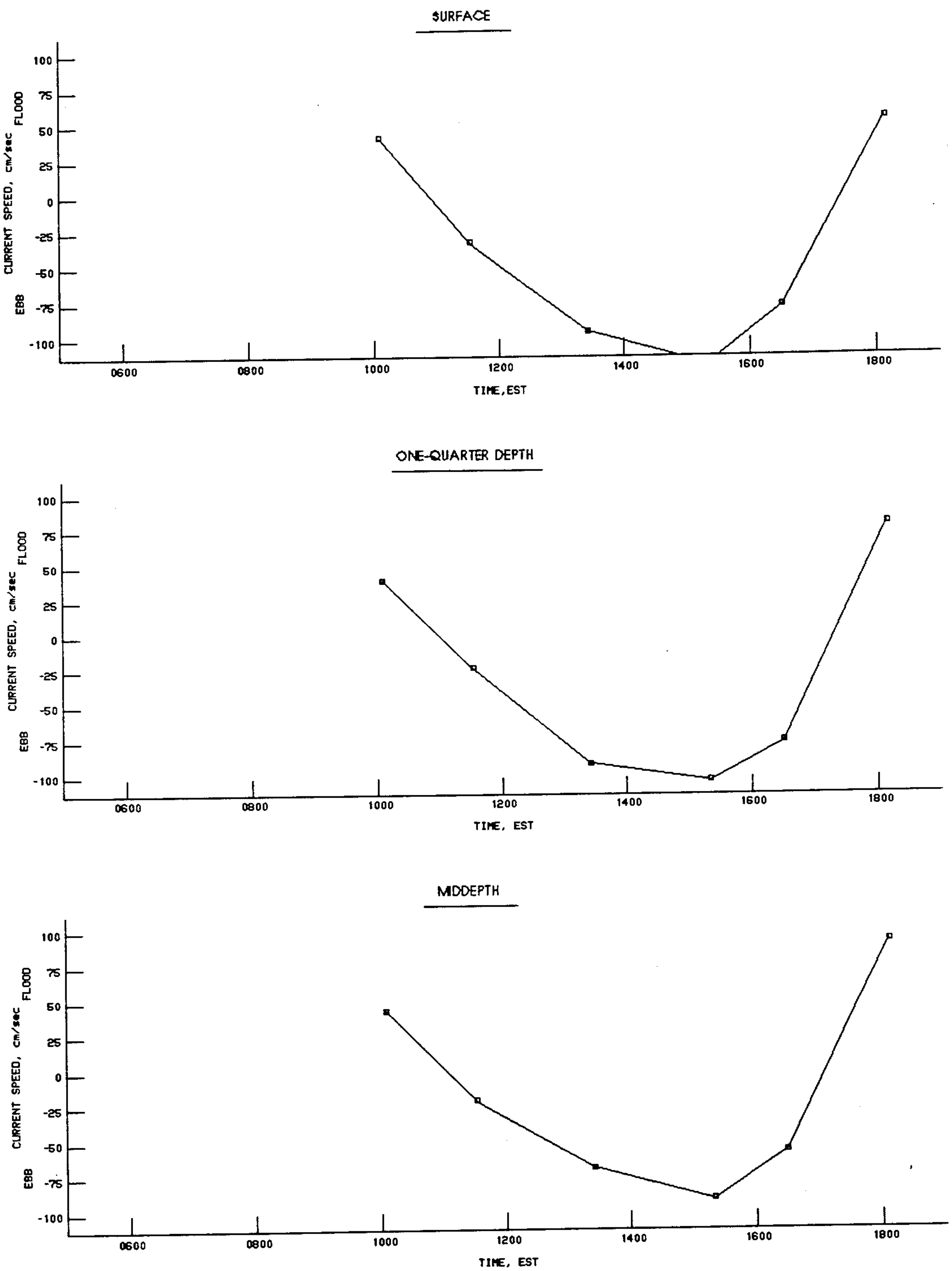
CURRENT SPEED
STATION R3.1 (600)
SURFACE, ONE-QUARTER DEPTH, AND MIDDEPTH
08/19/93



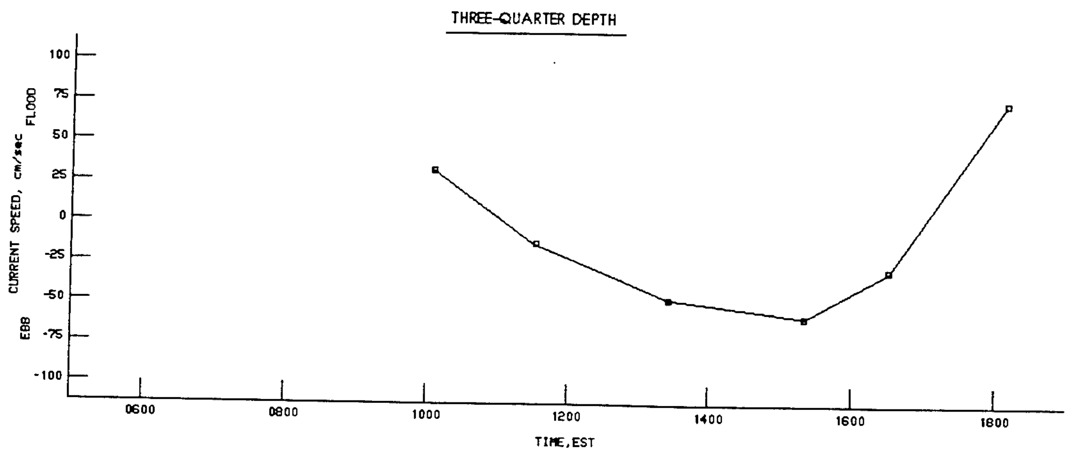


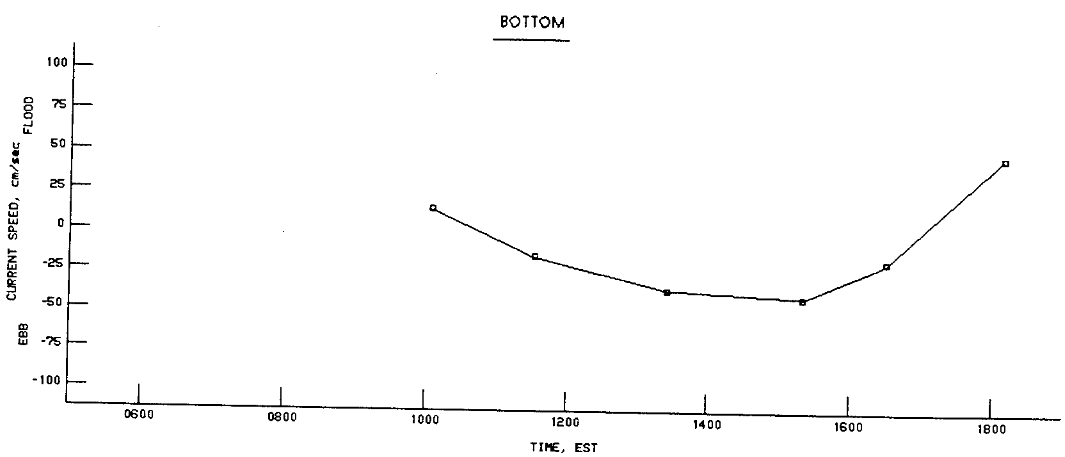
CURRENT SPEED
STATION R3.1 (600)
THREE-QUARTER DEPTH AND BOTTOM
08/19/93

Plate 56



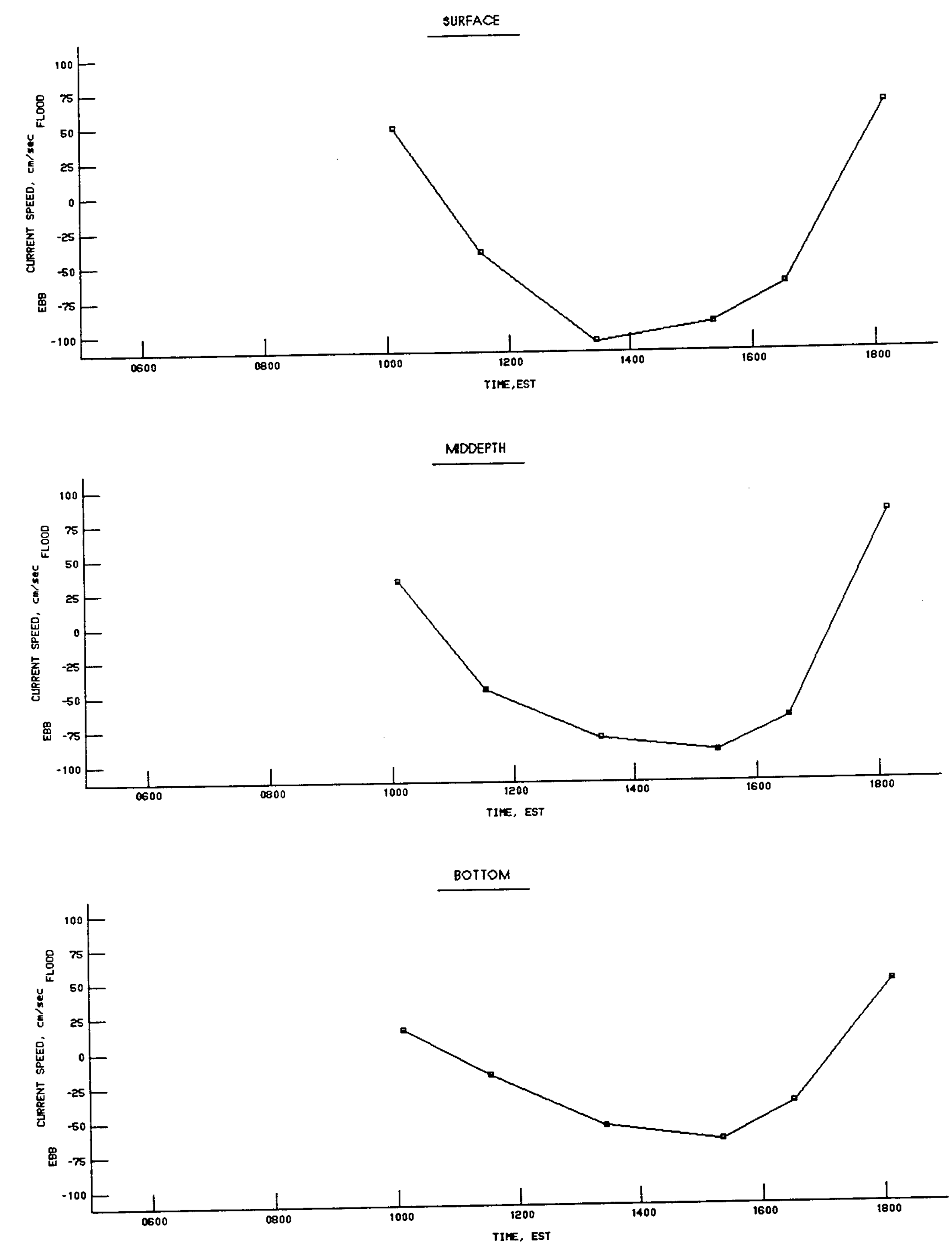
CURRENT SPEED
STATION R3.1 (900)
SURFACE, ONE-QUARTER DEPTH, AND MIDDEPTH
08/19/93



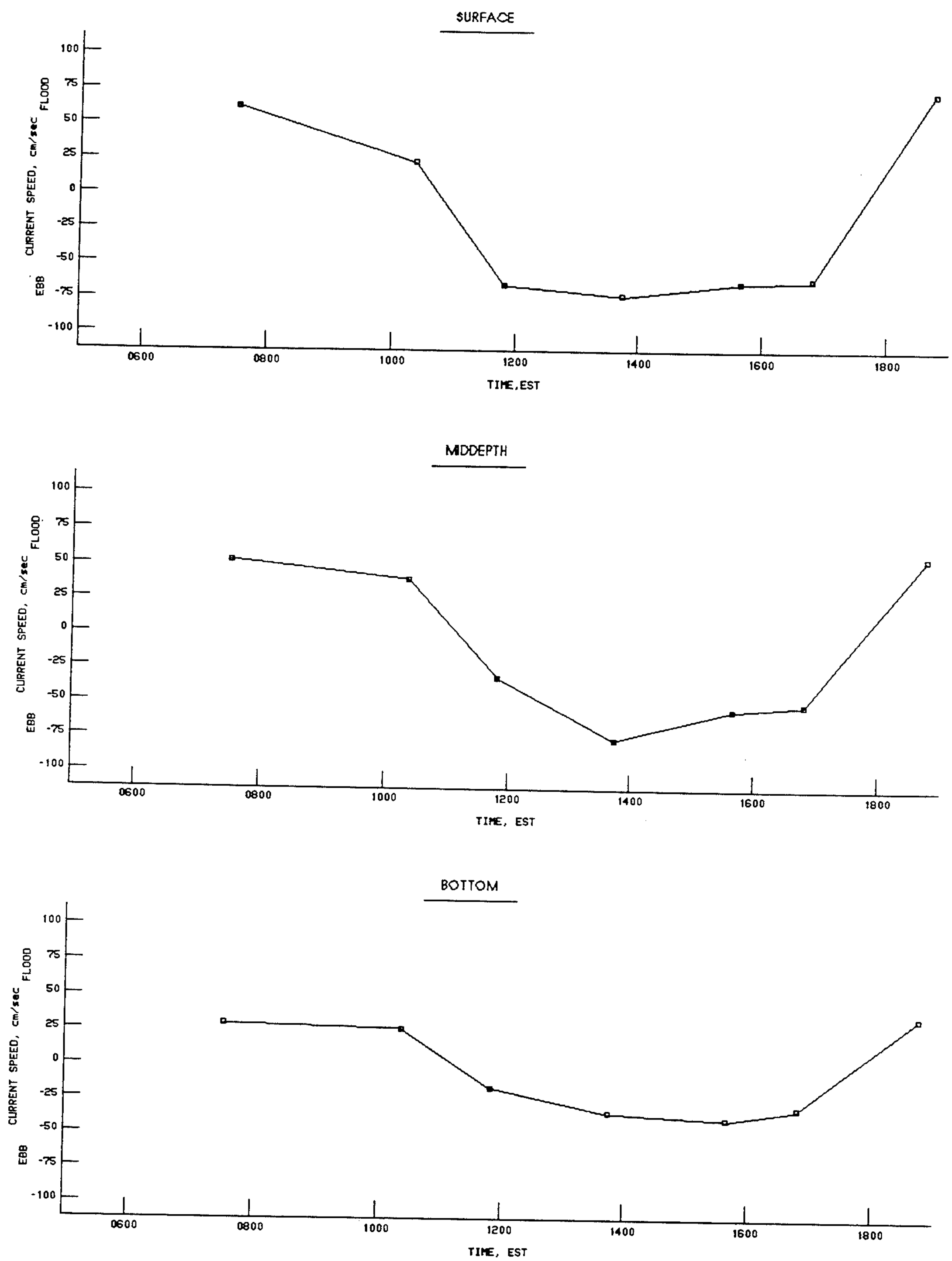


CURRENT SPEED
STATION R3.1 (900)
THREE-QUARTER DEPTH AND BOTTOM
08/19/93

Plate 58

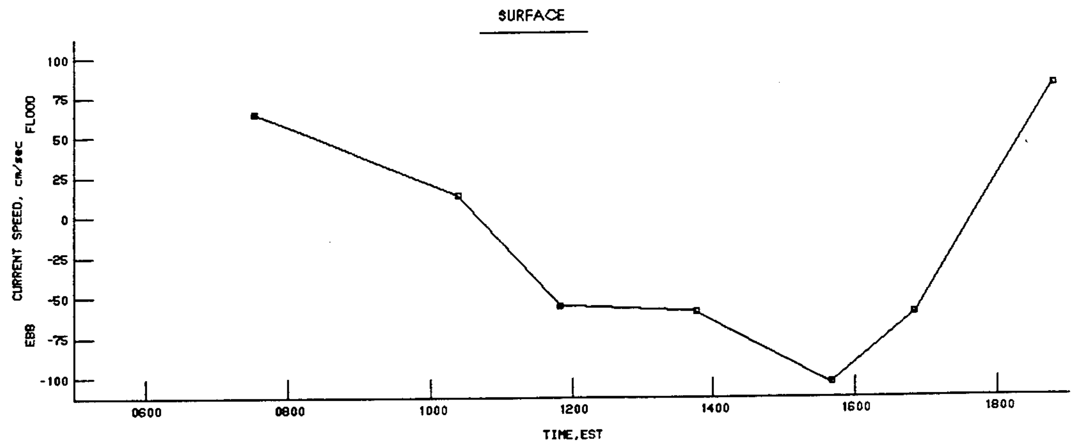


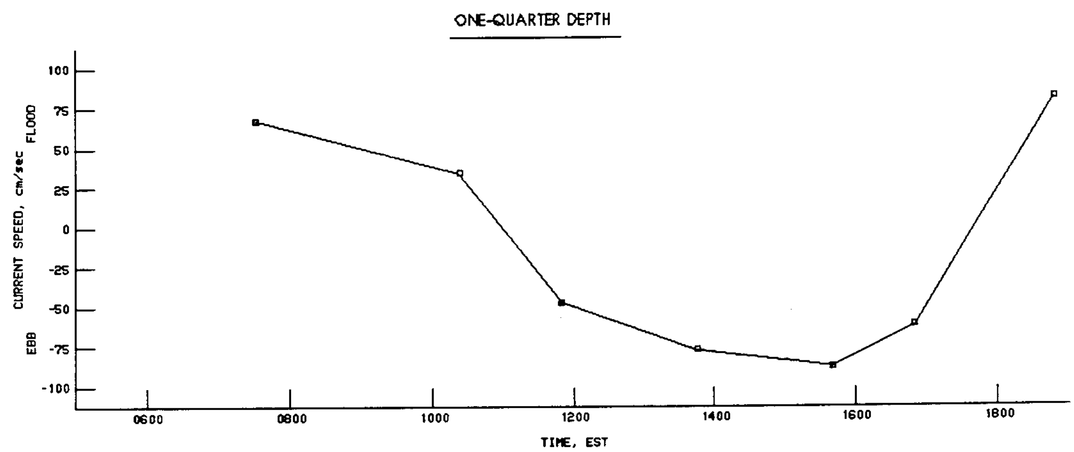
CURRENT SPEED
STATION R3.1 (1200)
SURFACE, MIDDEPTH, AND BOTTOM
08/19/93

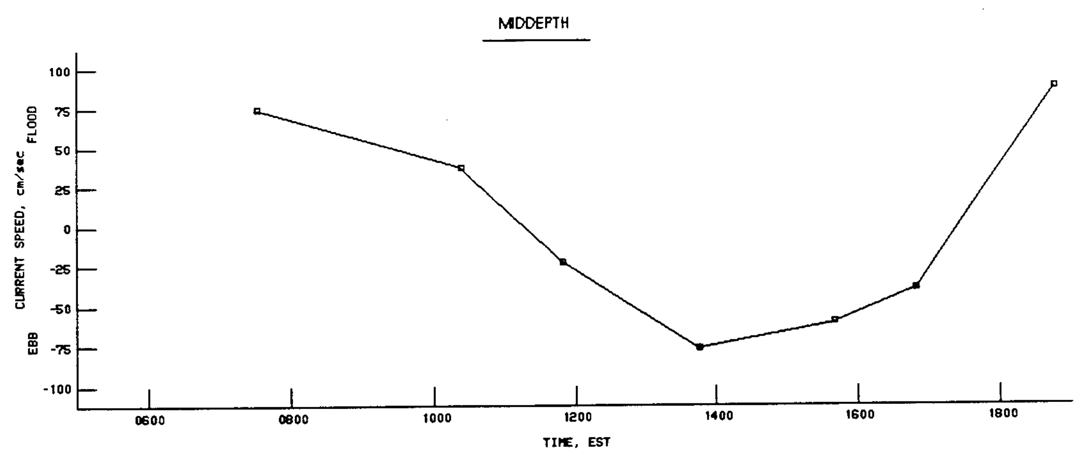


CURRENT SPEED
STATION R4.0 (600)
SURFACE, MIDDEPTH, AND BOTTOM
08/19/93

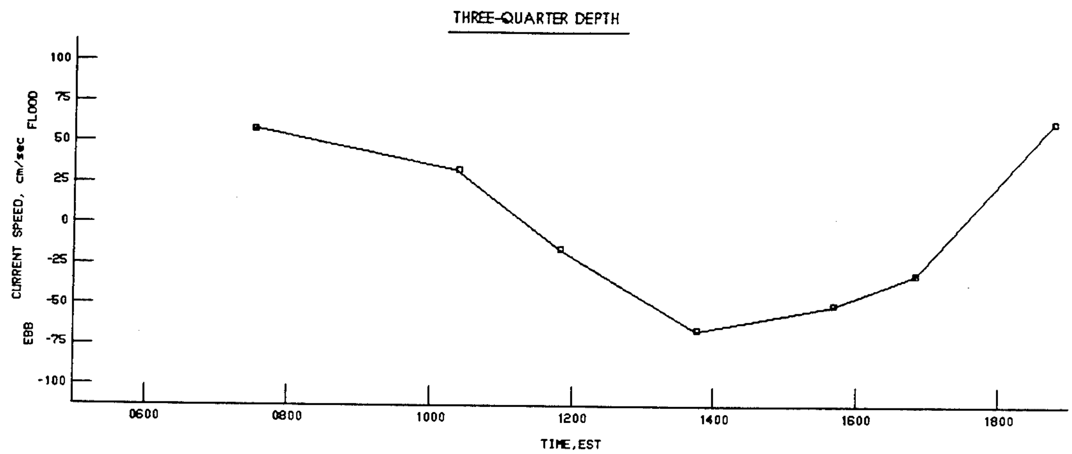
Plate 60

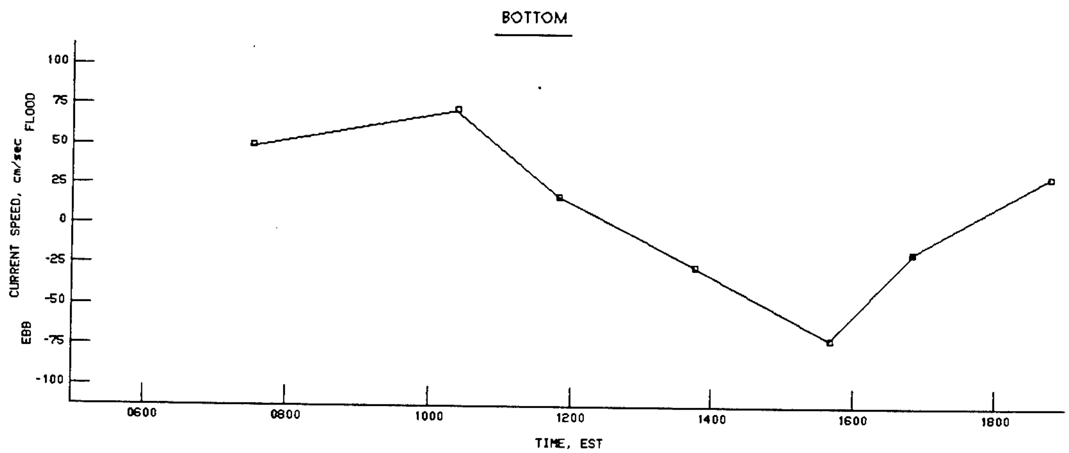




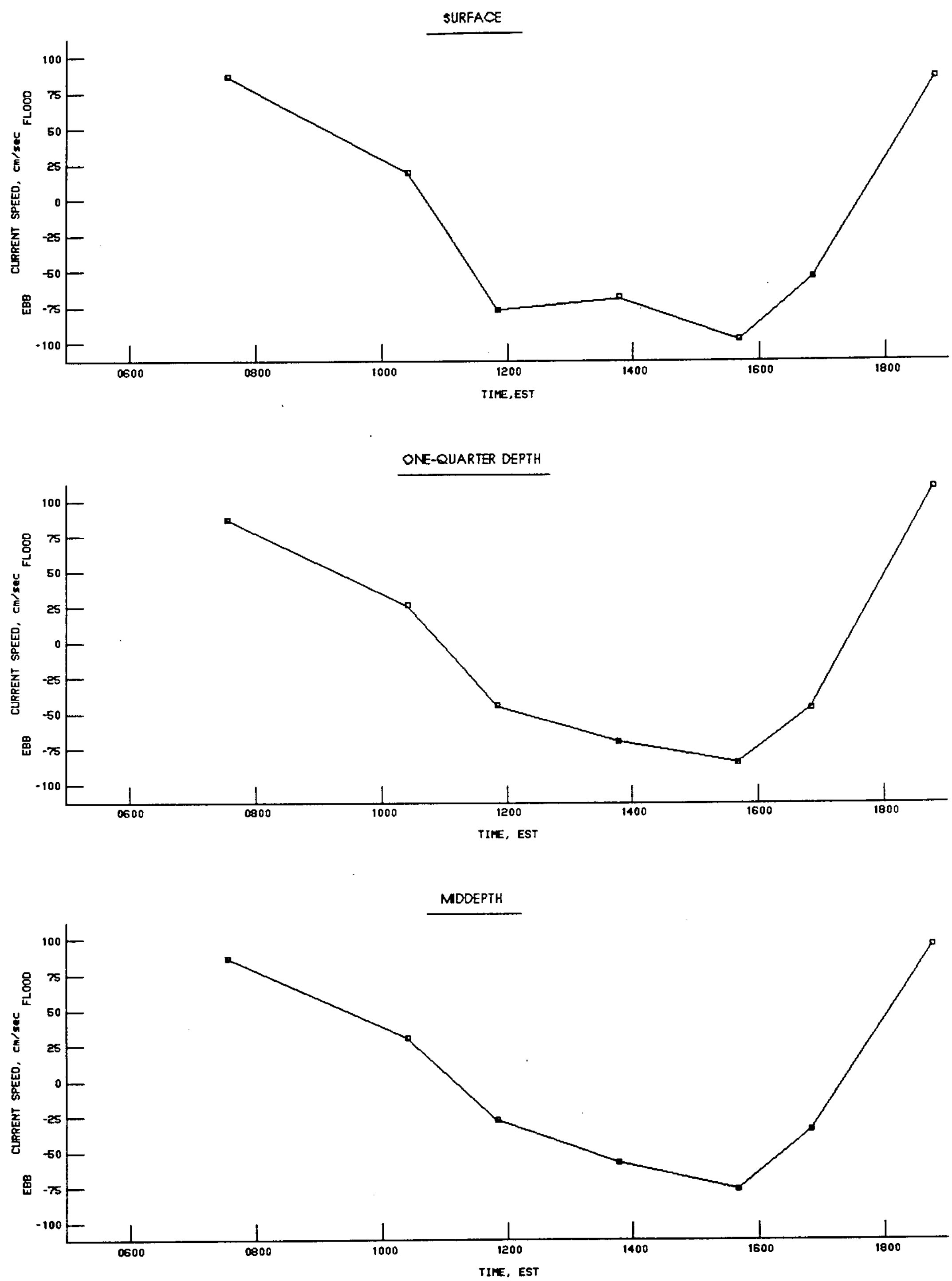


CURRENT SPEED
STATION R4.0 (900)
SURFACE, ONE-QUARTER DEPTH, AND MIDDEPTH
08/19/93

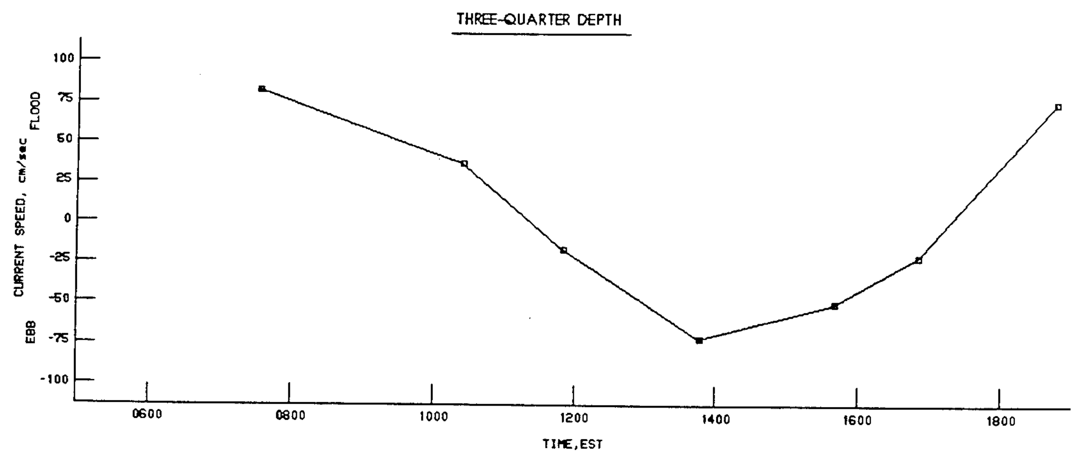


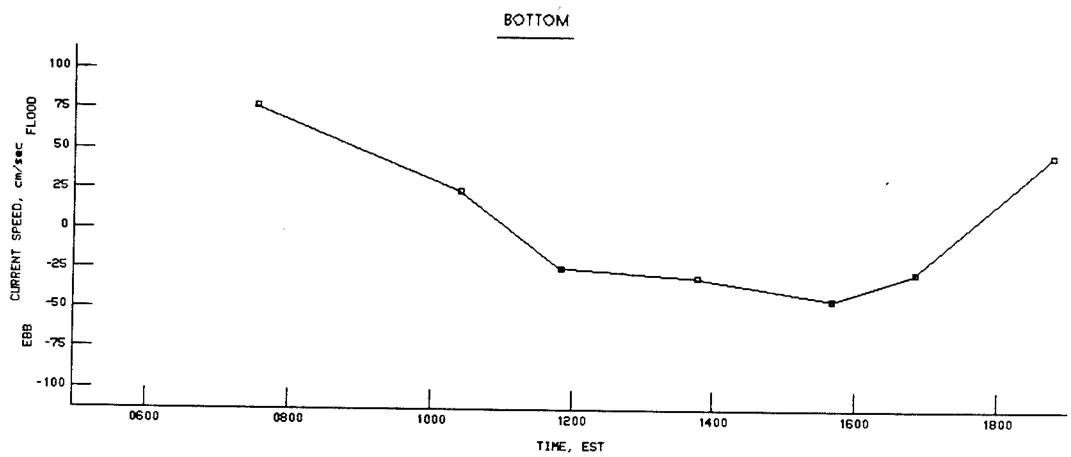


CURRENT SPEED
STATION R4.0 (900)
THREE-QUARTER DEPTH AND BOTTOM
08/19/93

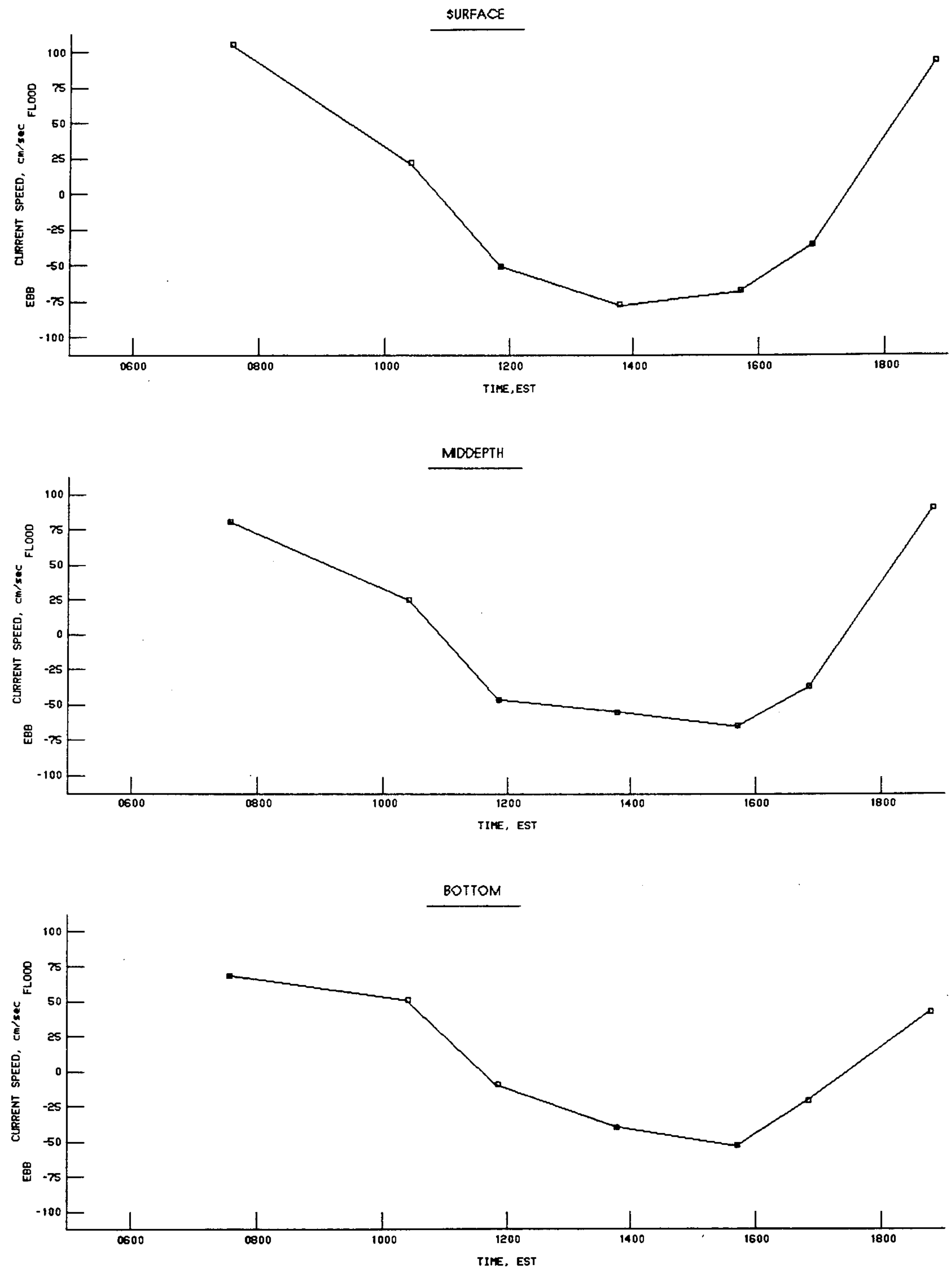


CURRENT SPEED
STATION R4.0 (1200)
SURFACE, ONE-QUARTER DEPTH, AND MIDDEPTH
08/19/93

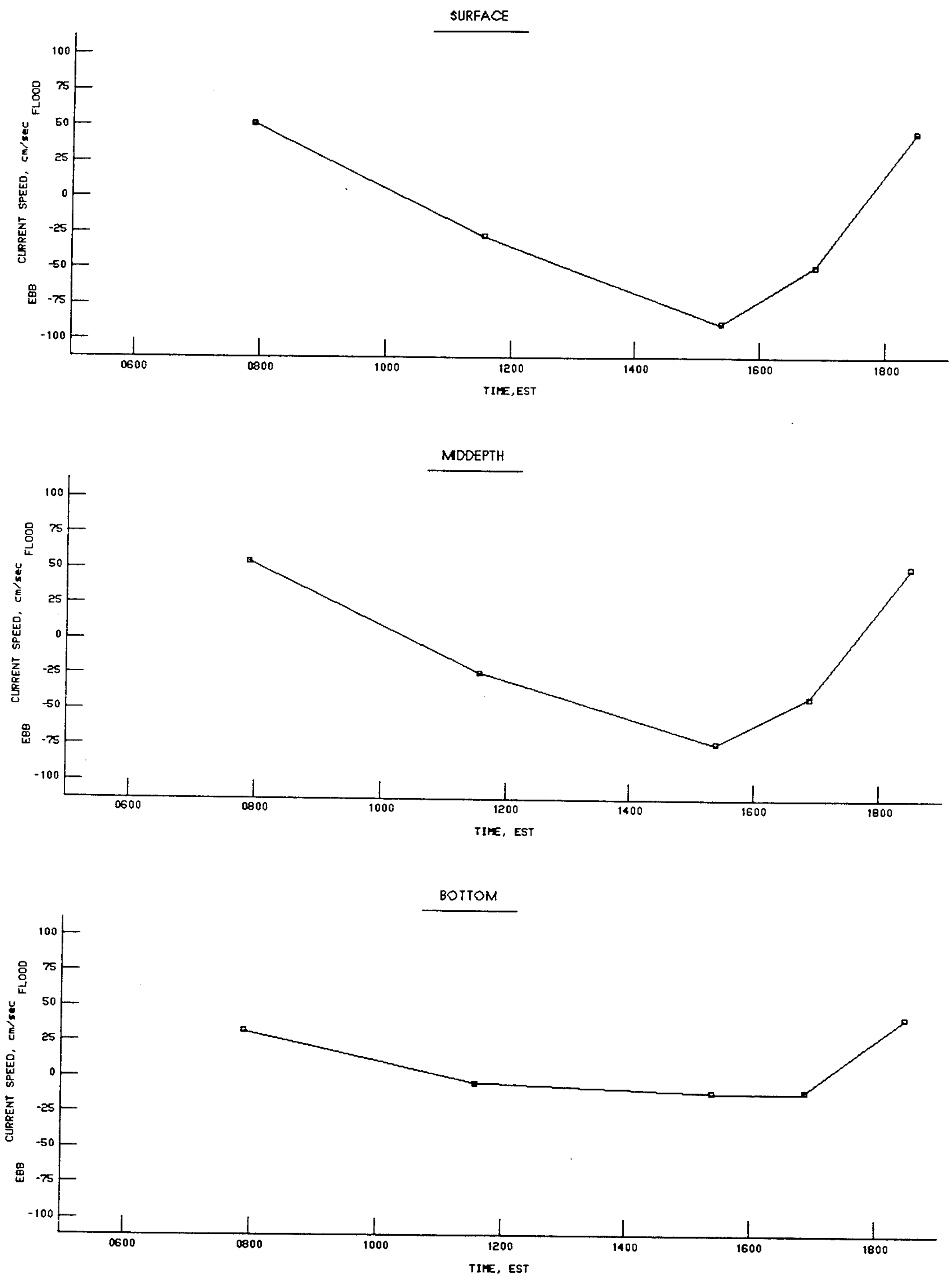




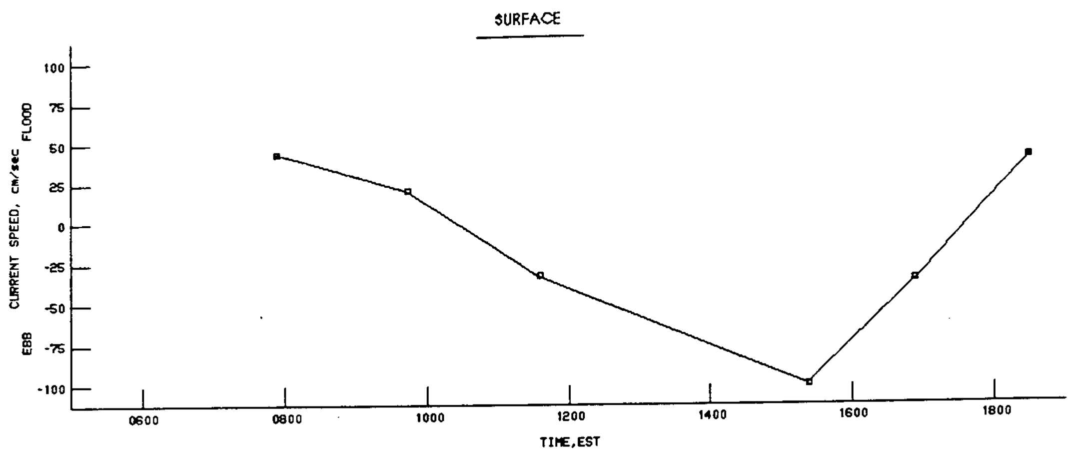
CURRENT SPEED
STATION R4.0 (1200)
THREE-QUARTER DEPTH AND BOTTOM
08/19/93

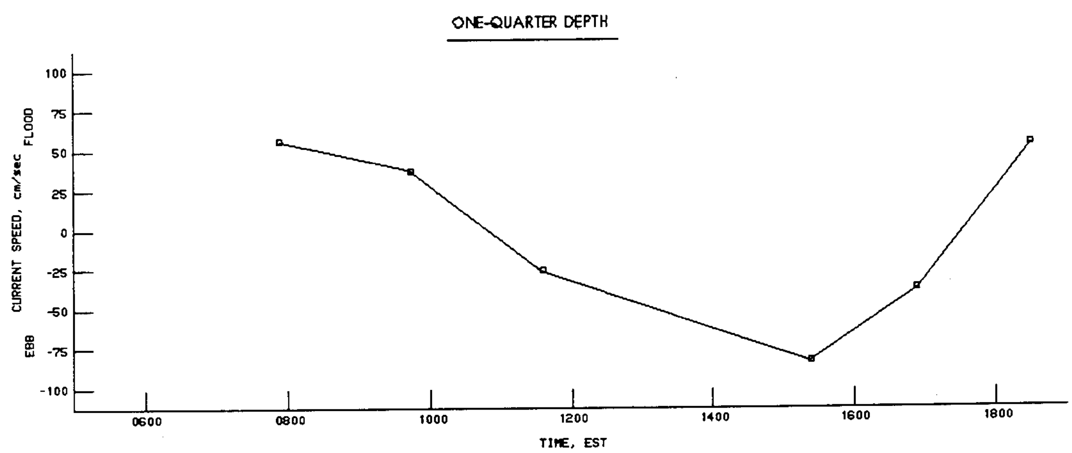


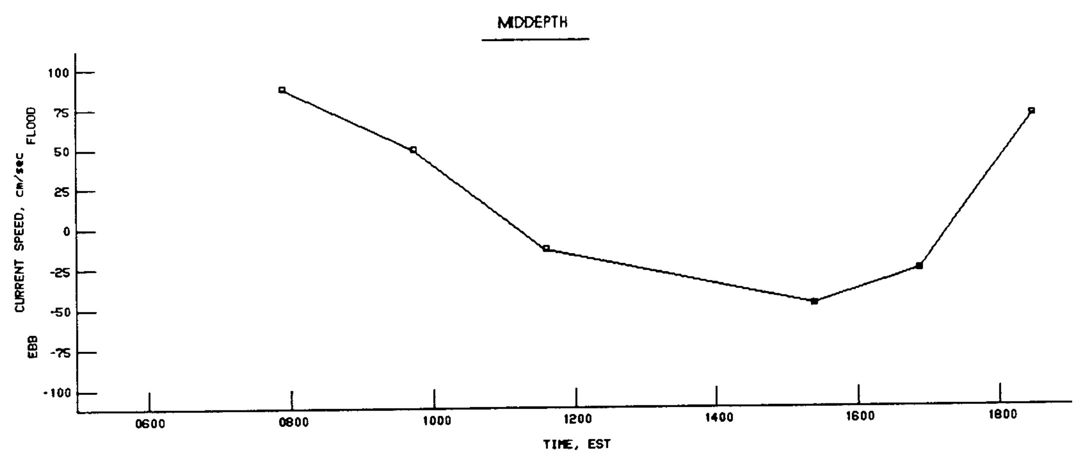
CURRENT SPEED
STATION R4.0 (1500)
SURFACE, MIDDEPTH, AND BOTTOM
08/19/93



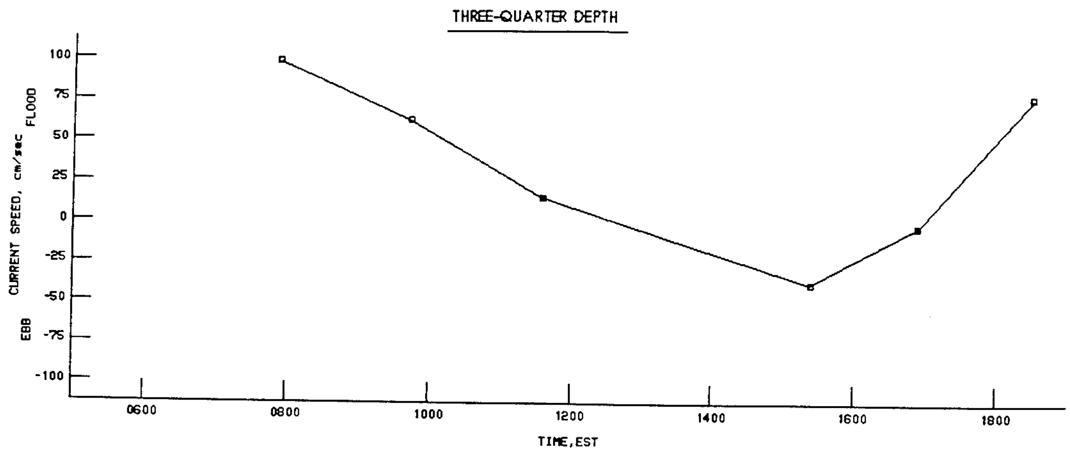
CURRENT SPEED
STATION R5.0 (800)
SURFACE, MIDDEPTH, AND BOTTOM
08/19/93

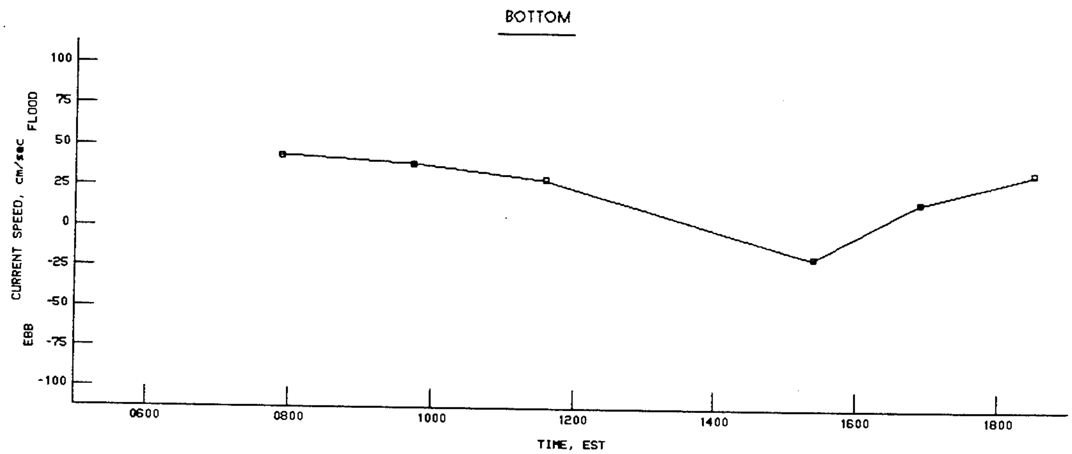




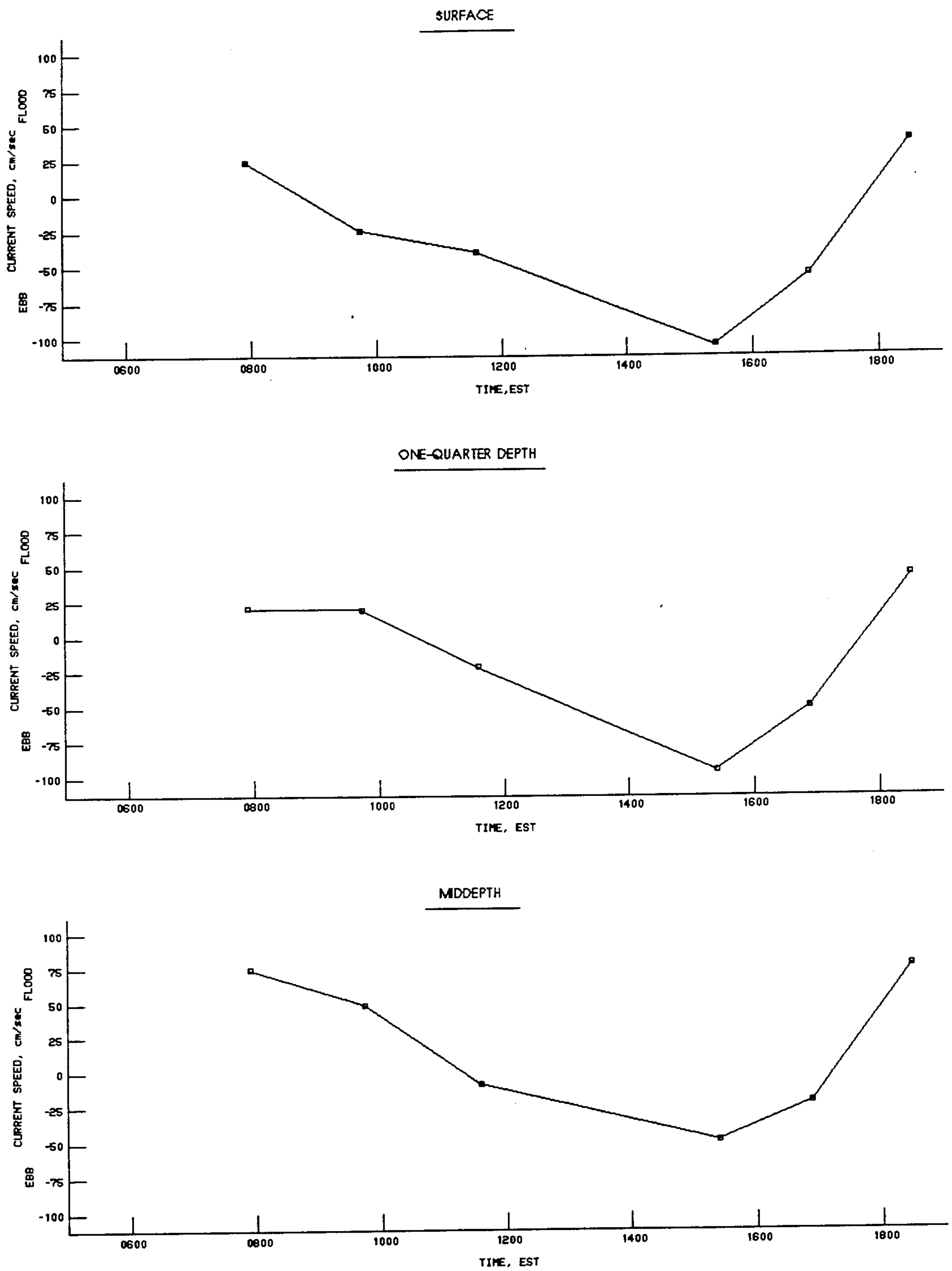


CURRENT SPEED
STATION R5.0 (1000)
SURFACE, ONE-QUARTER DEPTH, AND MIDDEPTH
08/19/93

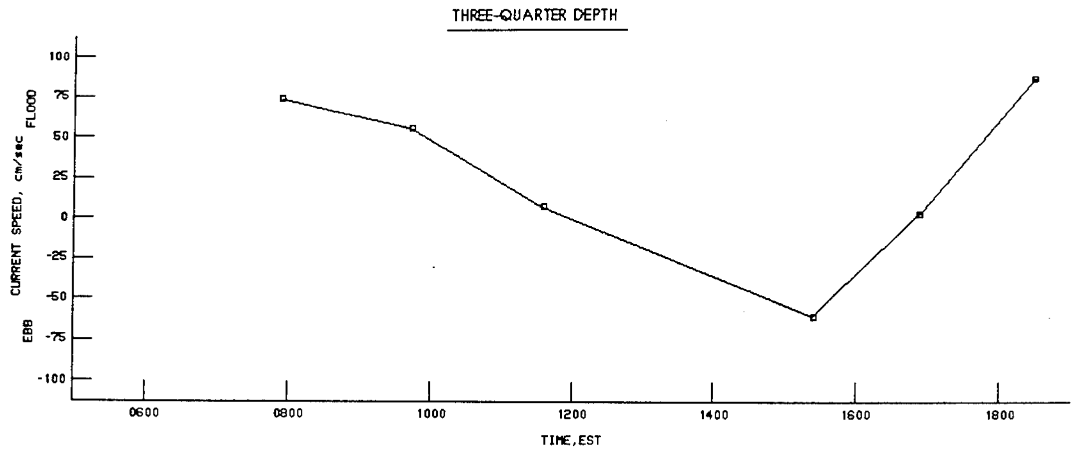


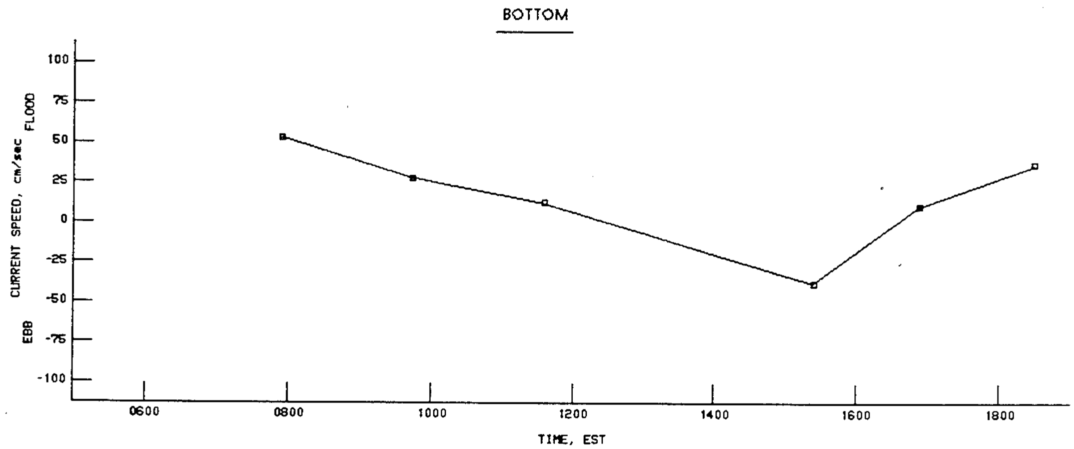


CURRENT SPEED
STATION R5.0 (1000)
THREE-QUARTER DEPTH AND BOTTOM
08/19/93

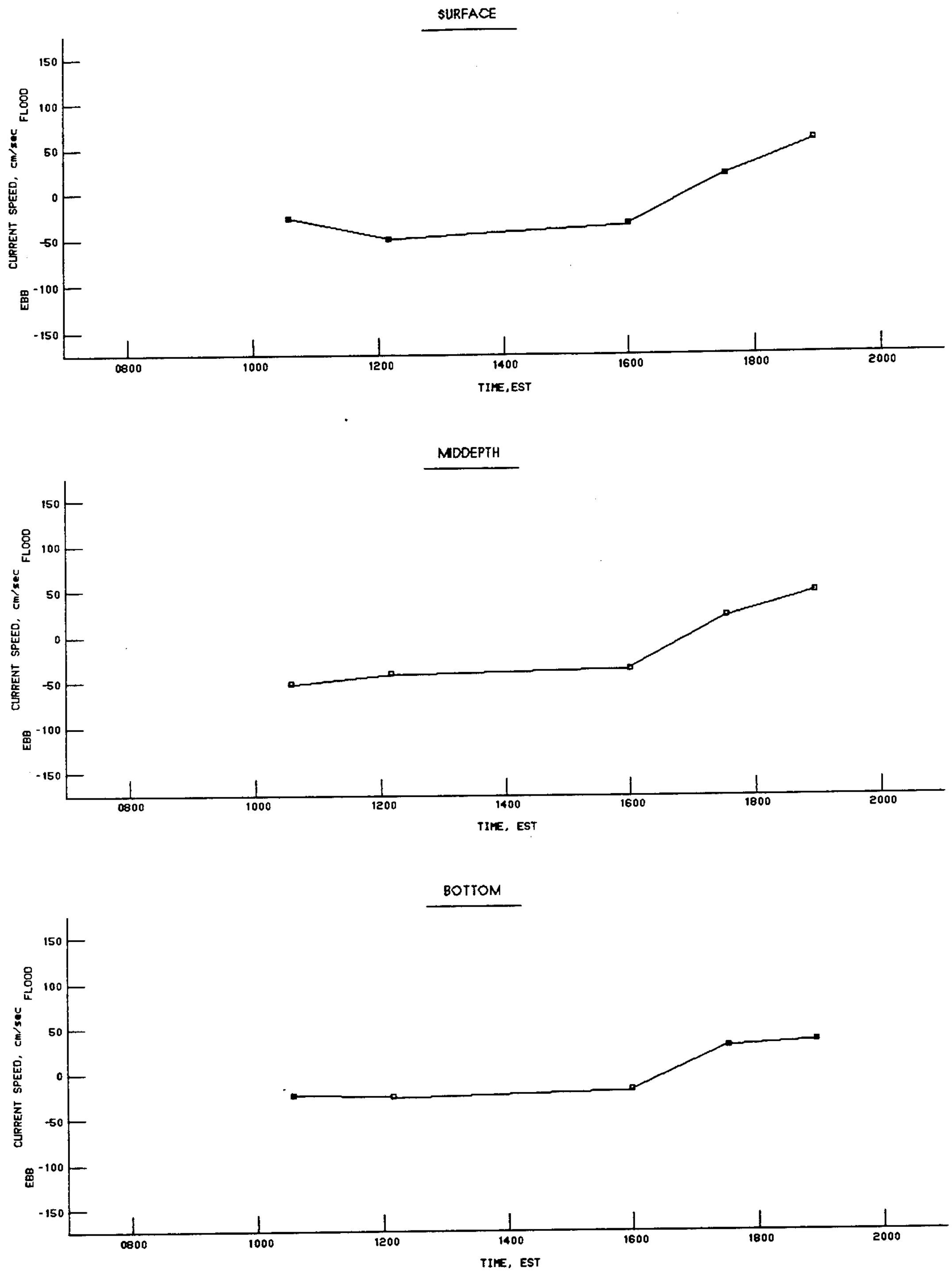


CURRENT SPEED
STATION R5.0 (1200)
SURFACE, ONE-QUARTER DEPTH, AND MIDDEPTH
08/19/93

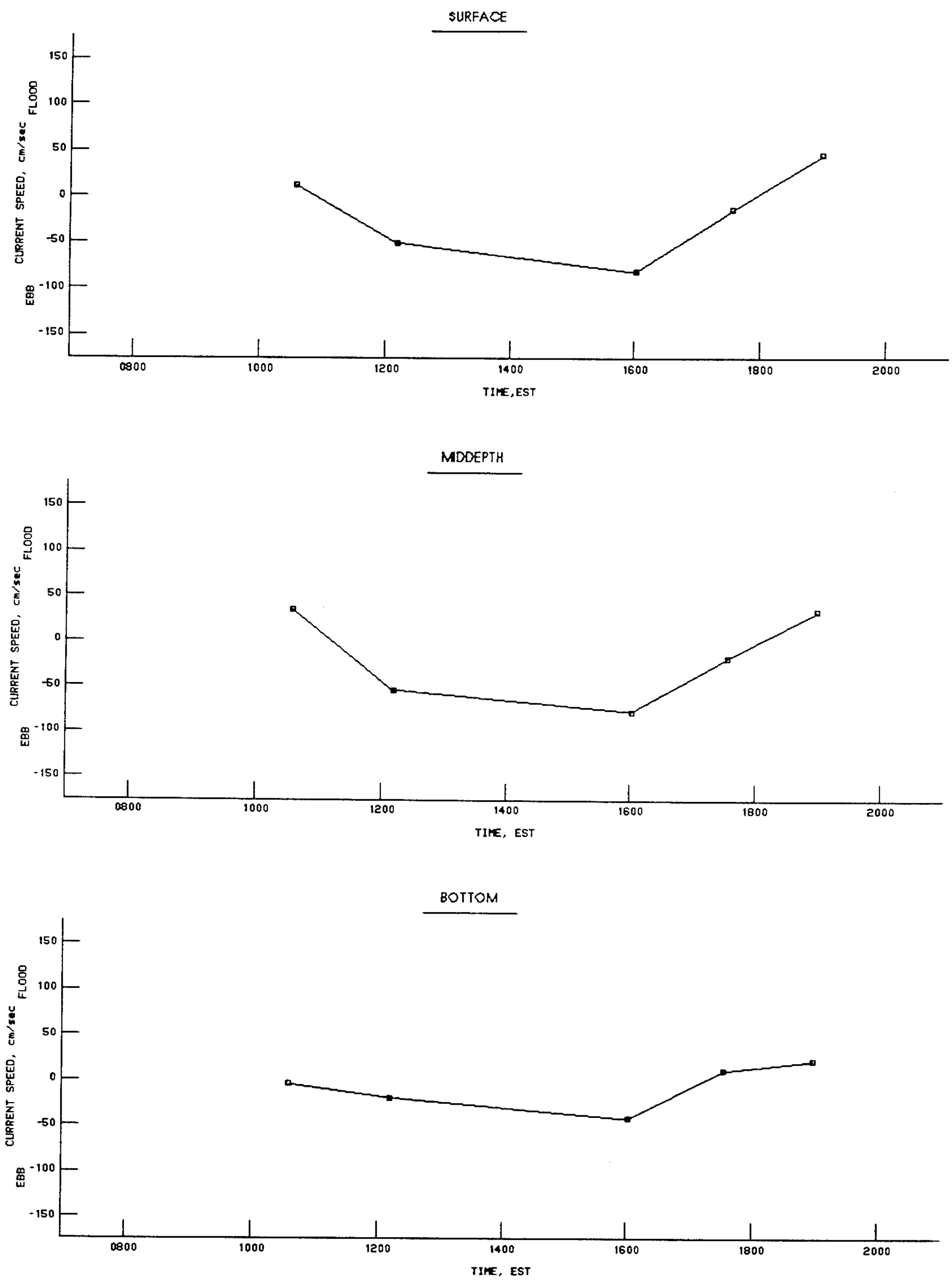




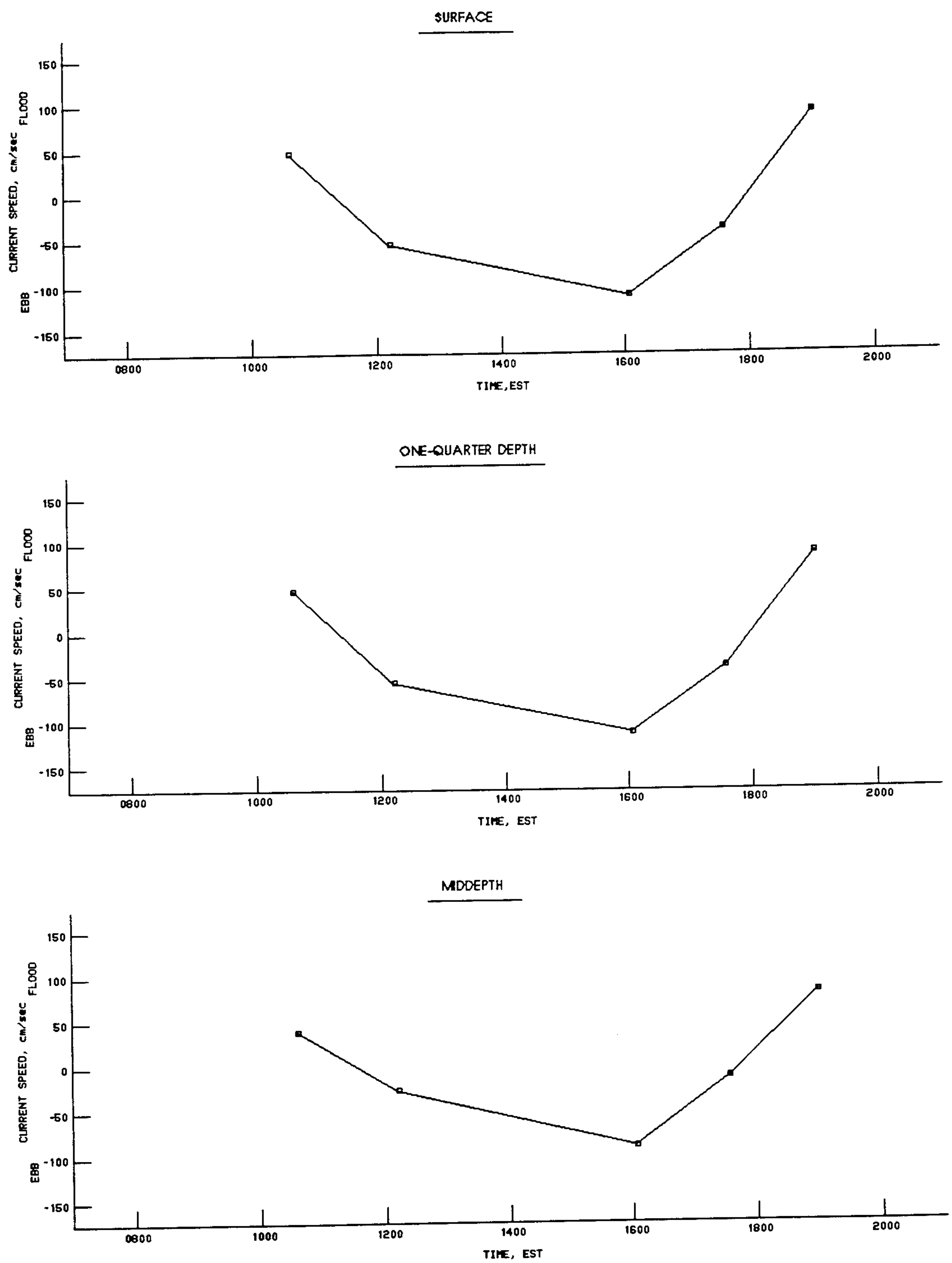
CURRENT SPEED
STATION R5.0 (1200)
THREE-QUARTER DEPTH AND BOTTOM
08/19/93



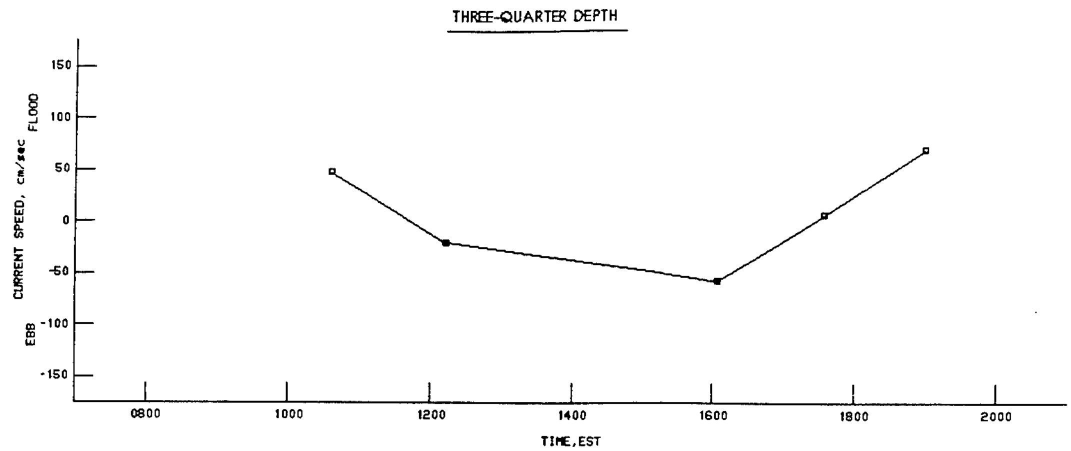
CURRENT SPEED
STATION R6.0 (300)
SURFACE, MIDDEPTH, AND BOTTOM
08/19/93

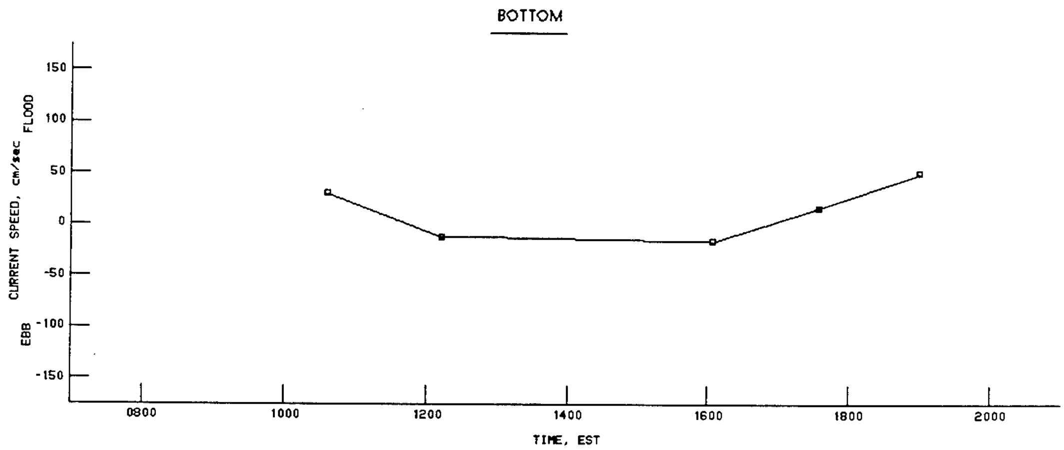


CURRENT SPEED
STATION R6.0 (1400)
SURFACE, MIDDEPTH, AND BOTTOM
08/19/93

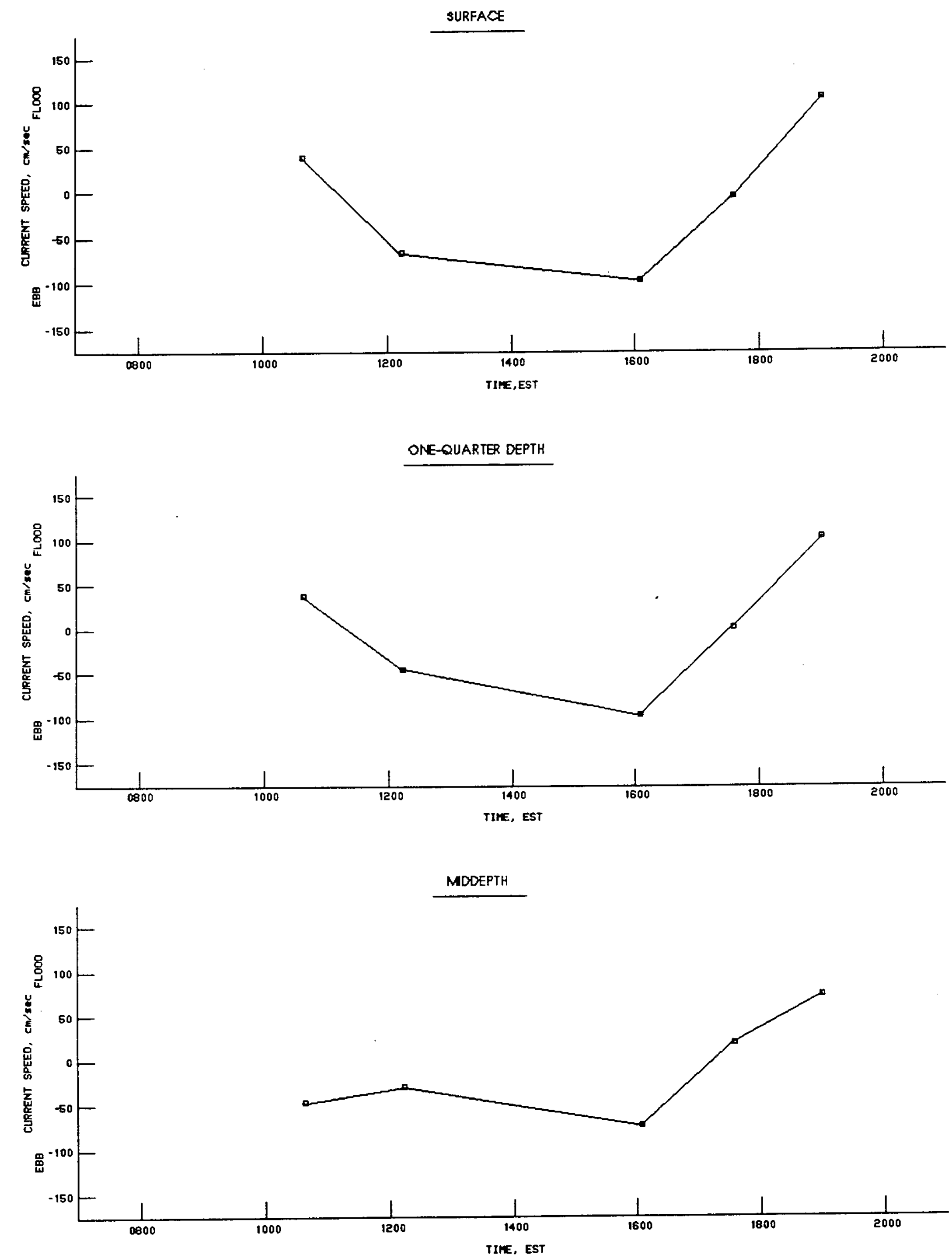


CURRENT SPEED
STATION R6.0 (2000)
SURFACE, ONE-QUARTER DEPTH, AND MIDDEPTH
08/19/93

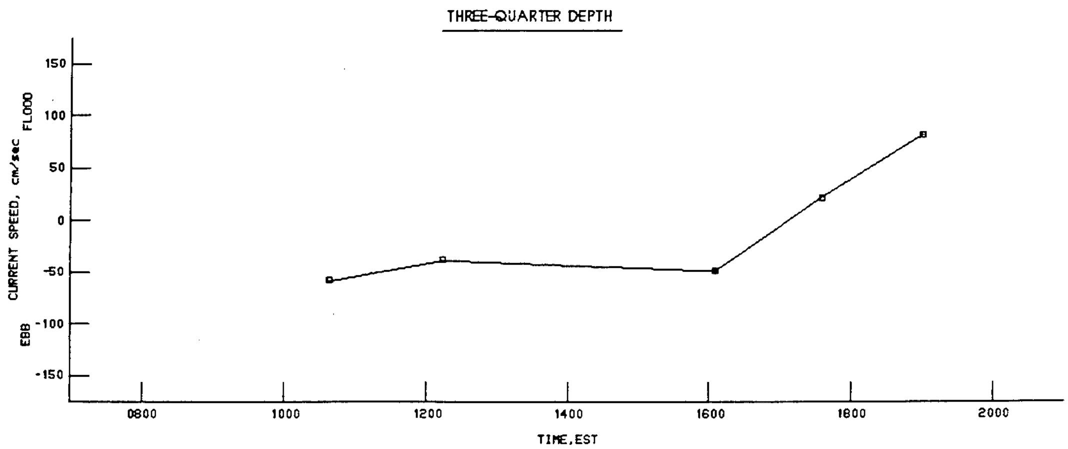


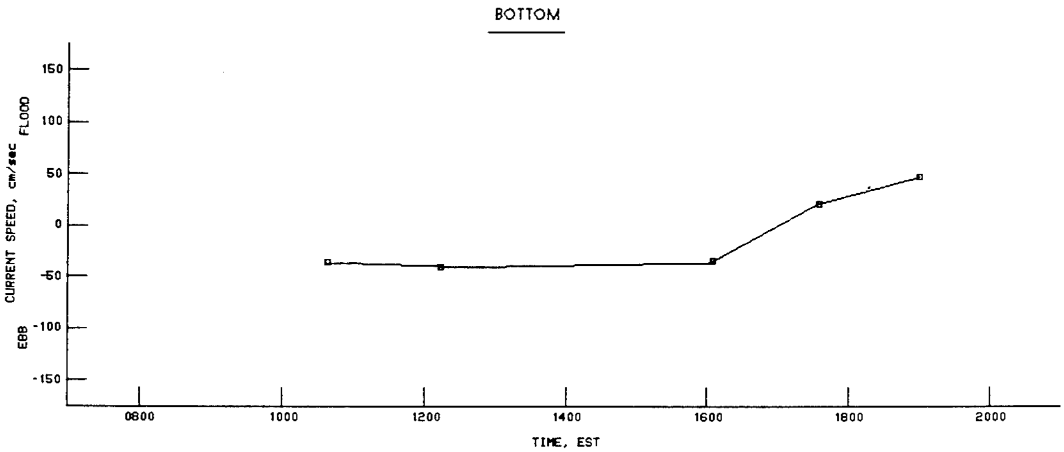


CURRENT SPEED
STATION R6.0 (2000)
THREE-QUARTER DEPTH AND BOTTOM
08/19/93

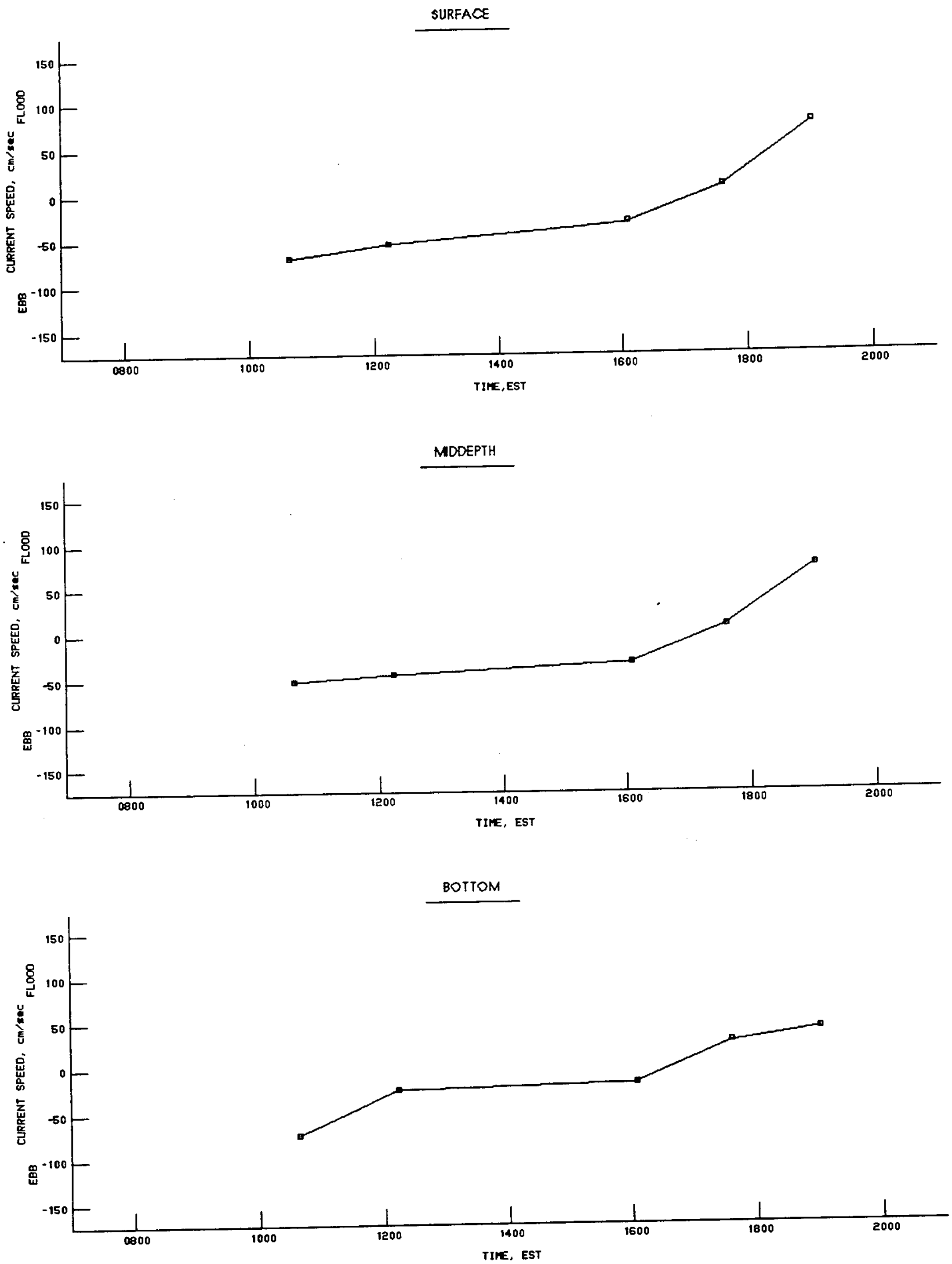


CURRENT SPEED
STATION R6.0 (2500)
SURFACE, ONE-QUARTER DEPTH, AND MIDDEPTH
08/19/93

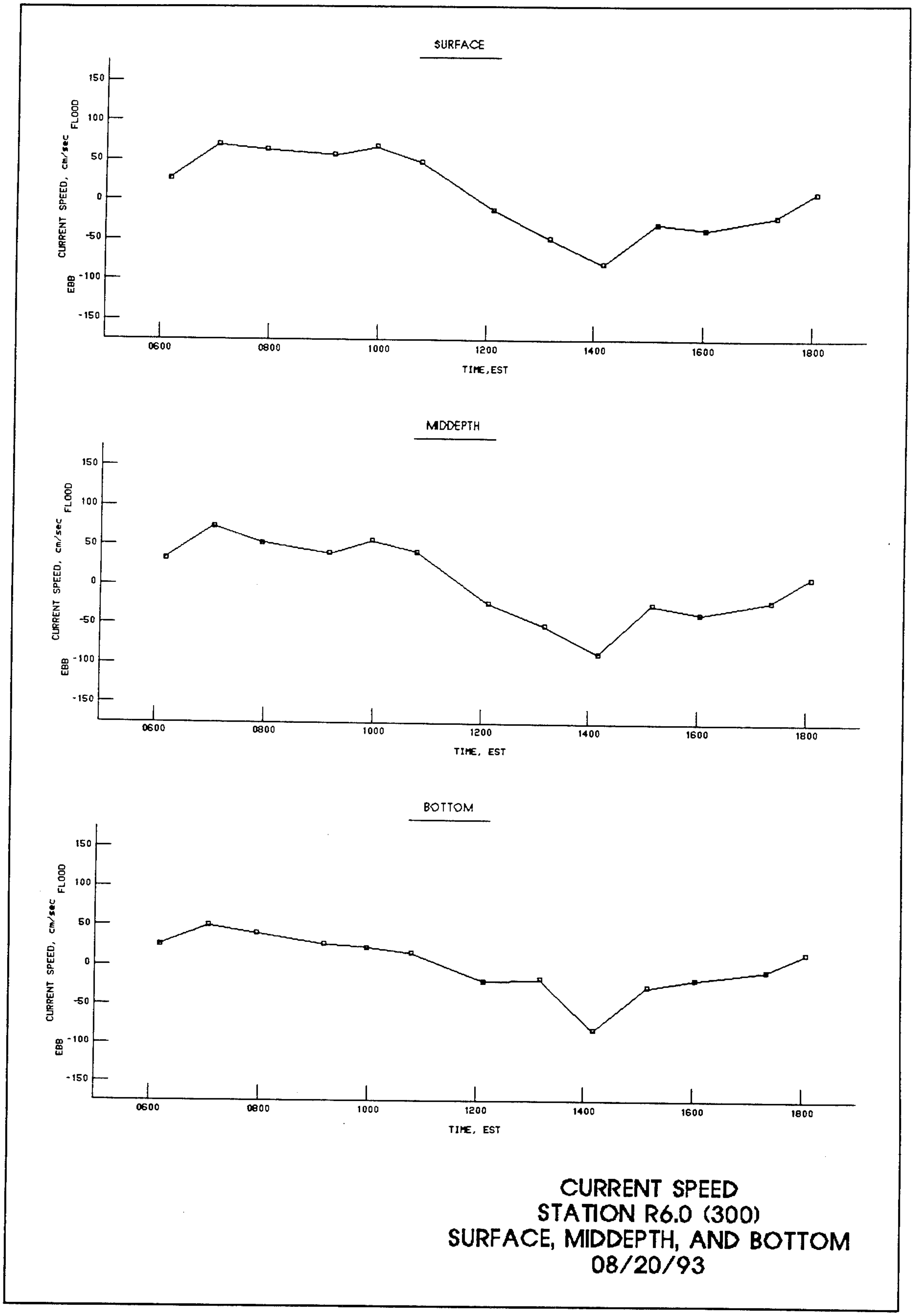


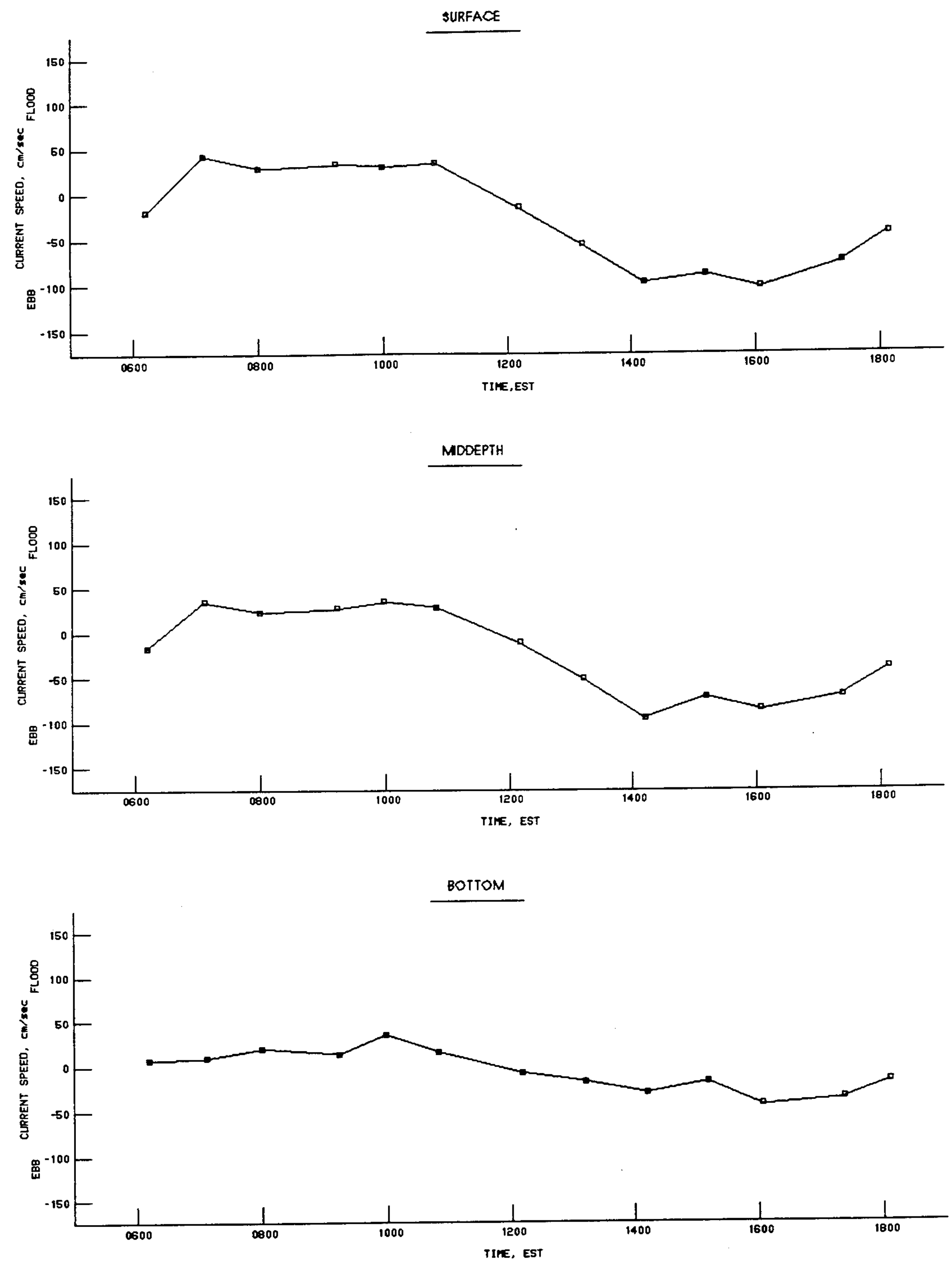


CURRENT SPEED
STATION R6.0 (2500)
THREE-QUARTER DEPTH AND BOTTOM
08/19/93

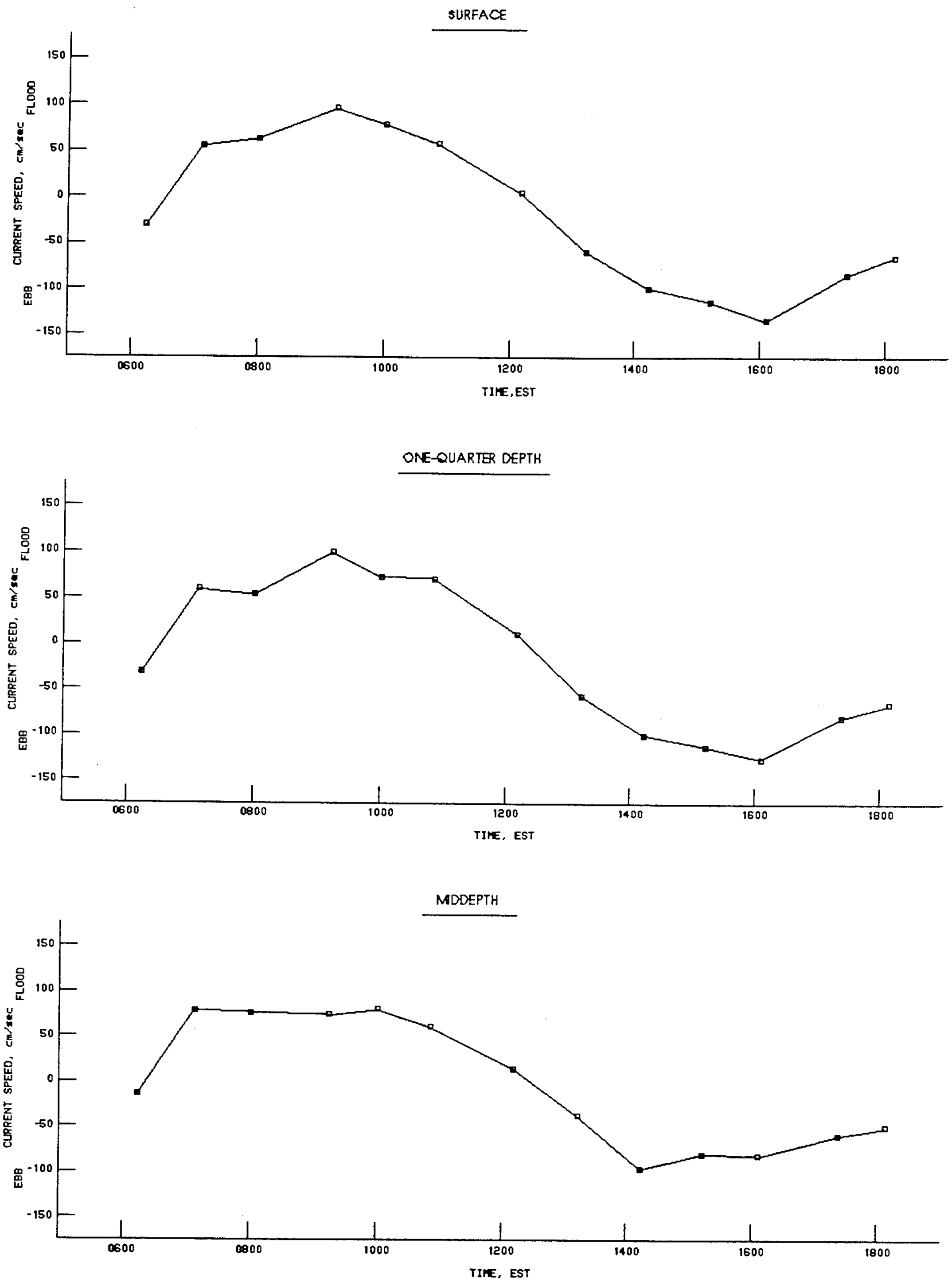


CURRENT SPEED
STATION R6.0 (3000)
SURFACE, MIDDEPTH, AND BOTTOM
08/19/93

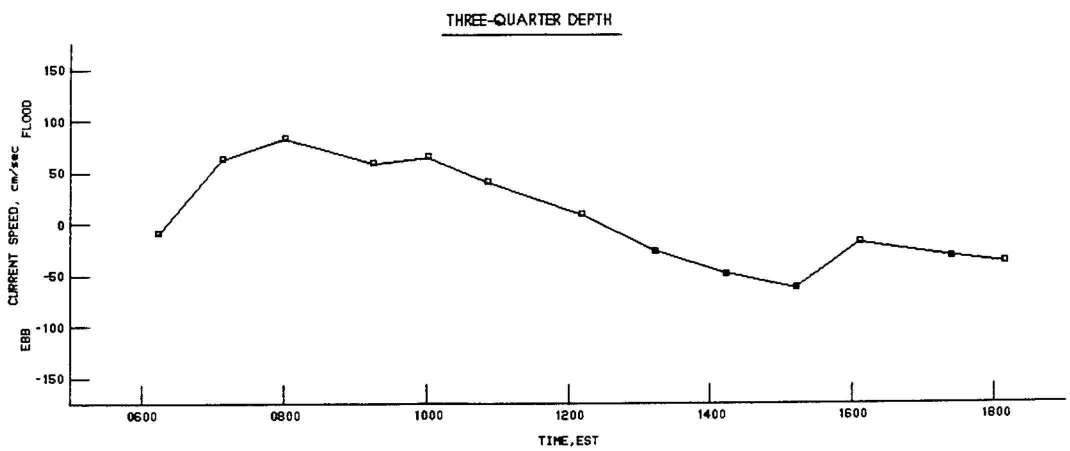

SURFACE
MIDDEPTH
BOTTOM
CURRENT SPEED, cm/sec
FLOOD
EBB
150
100
50
0
-50
-100
-150
0600
0800
1000
1200
1400
1600
1800
TIME, EST
CURRENT SPEED
STATION R6.0 (300)
SURFACE, MIDDEPTH, AND BOTTOM
08/20/93

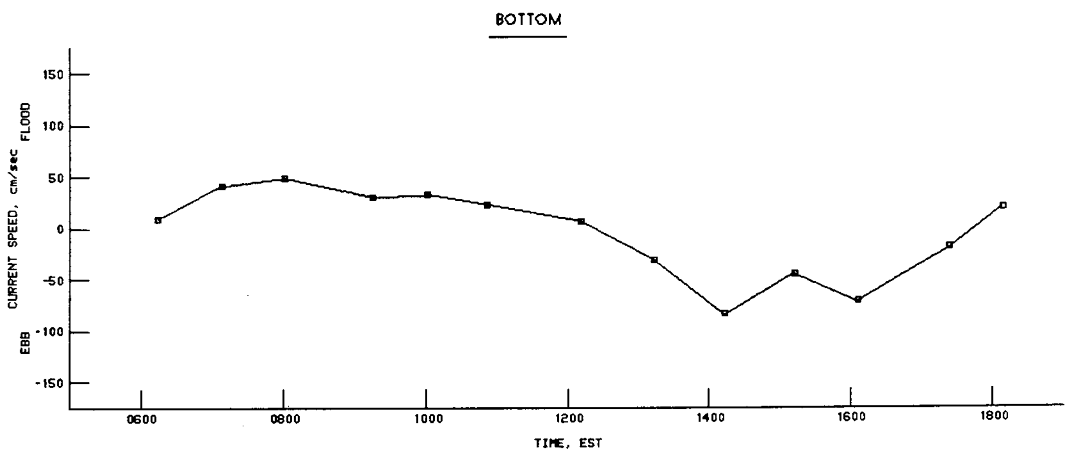


CURRENT SPEED
STATION R6.0 (1400)
SURFACE, MIDDEPTH, AND BOTTOM
08/20/93

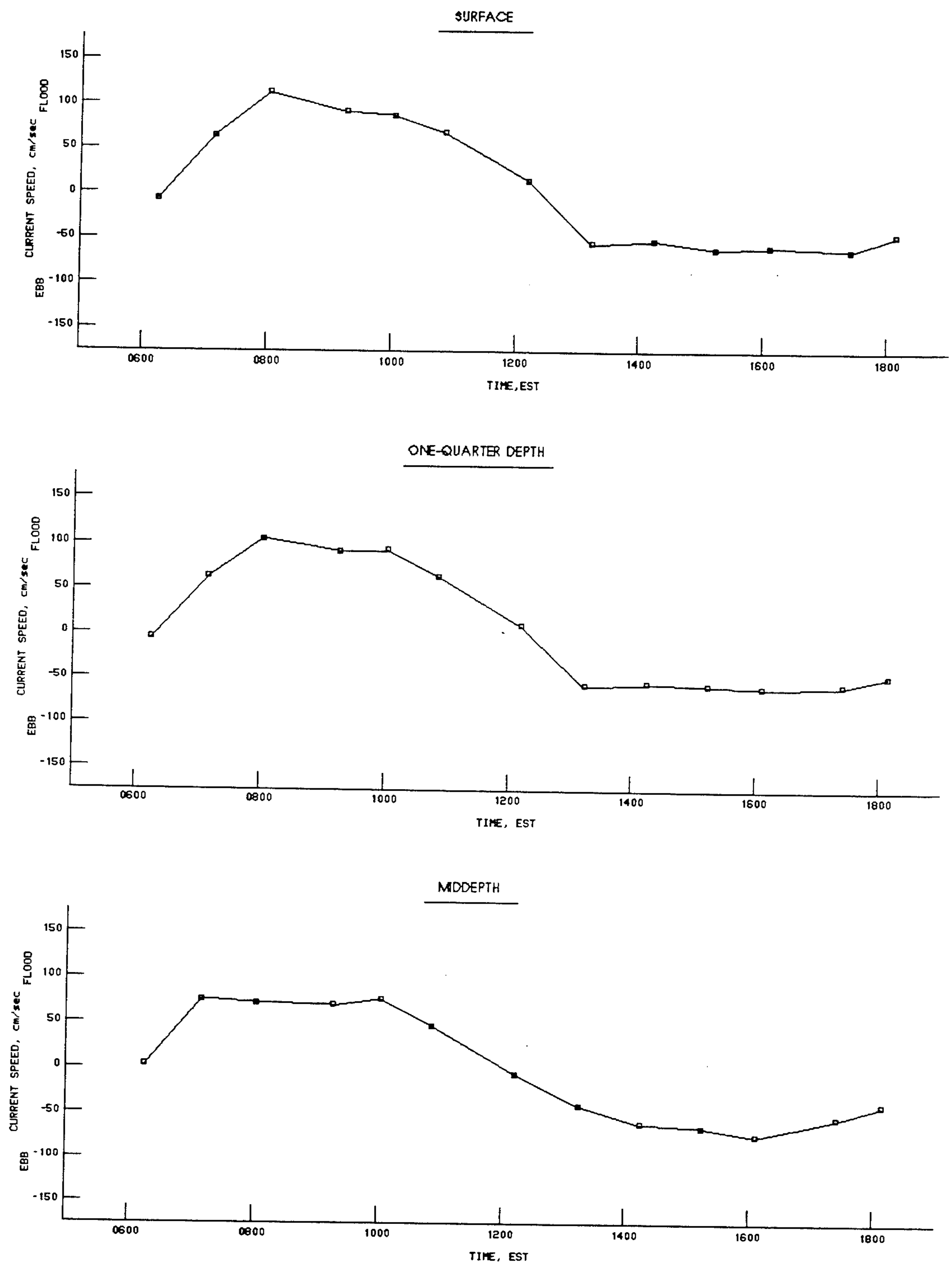


CURRENT SPEED
STATION R6.0 (2000)
SURFACE, ONE-QUARTER DEPTH, AND MIDDEPTH
08/20/93



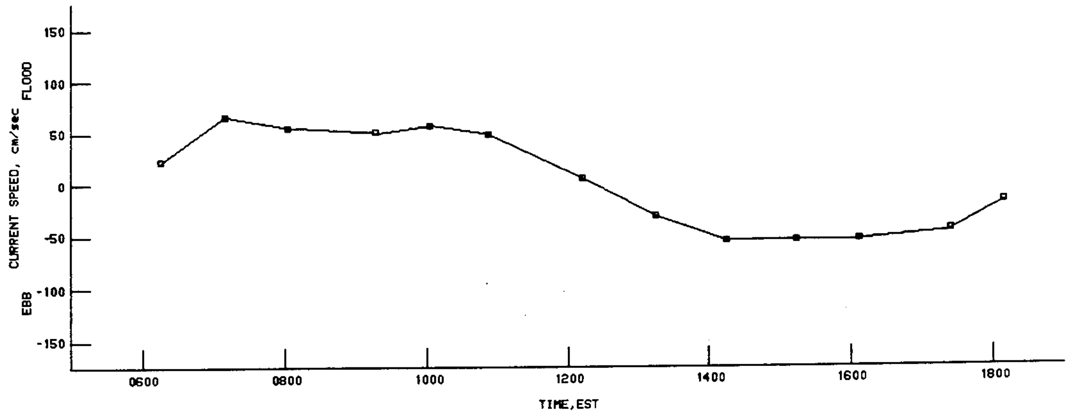


CURRENT SPEED
STATION R6.0 (2000)
THREE-QUARTER DEPTH AND BOTTOM
08/20/93

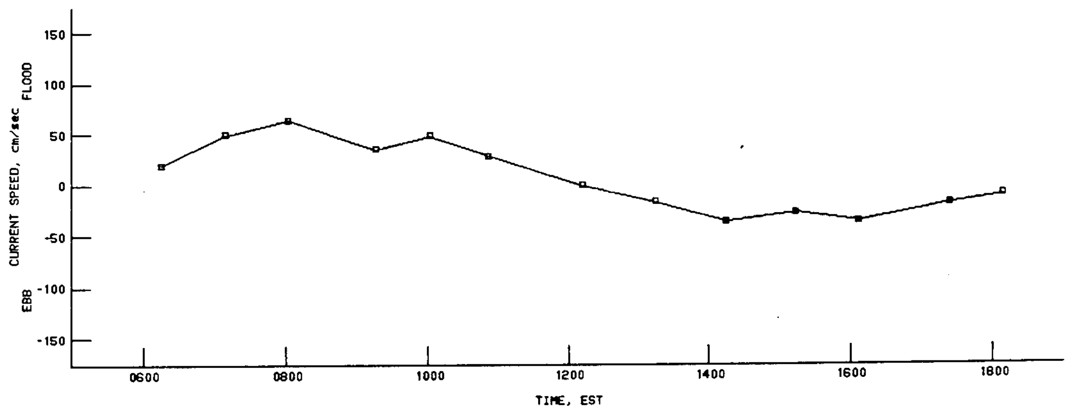


CURRENT SPEED
STATION R6.0 (2500)
SURFACE, ONE-QUARTER DEPTH, AND MIDDEPTH
08/20/93

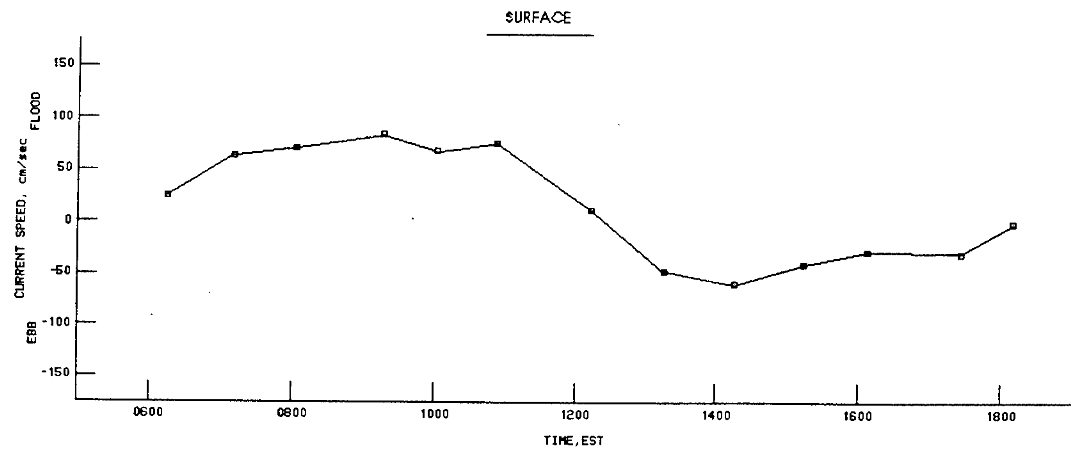
THREE-QUARTER DEPTH

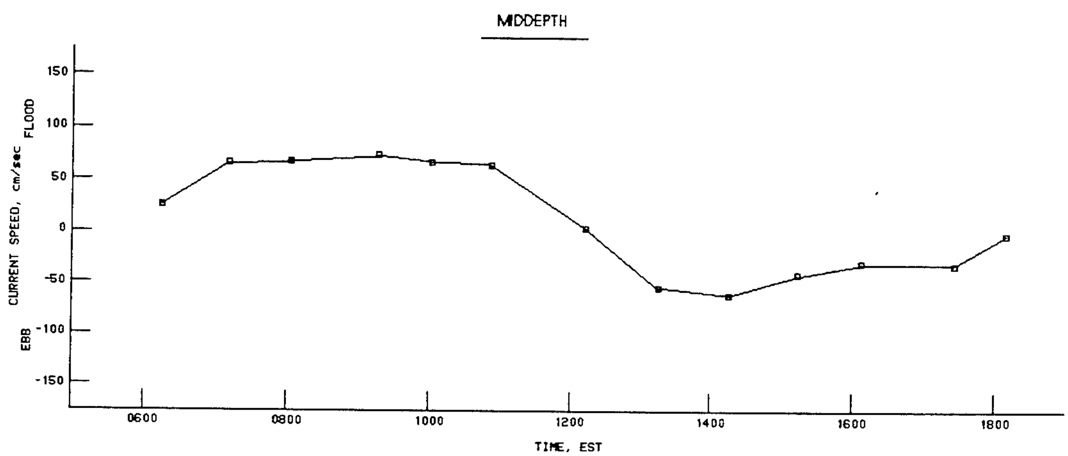


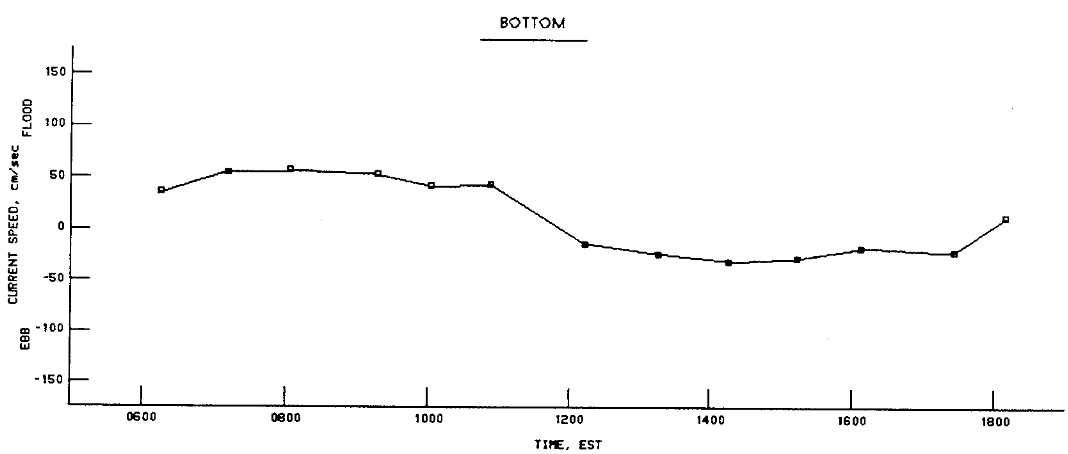
BOTTOM



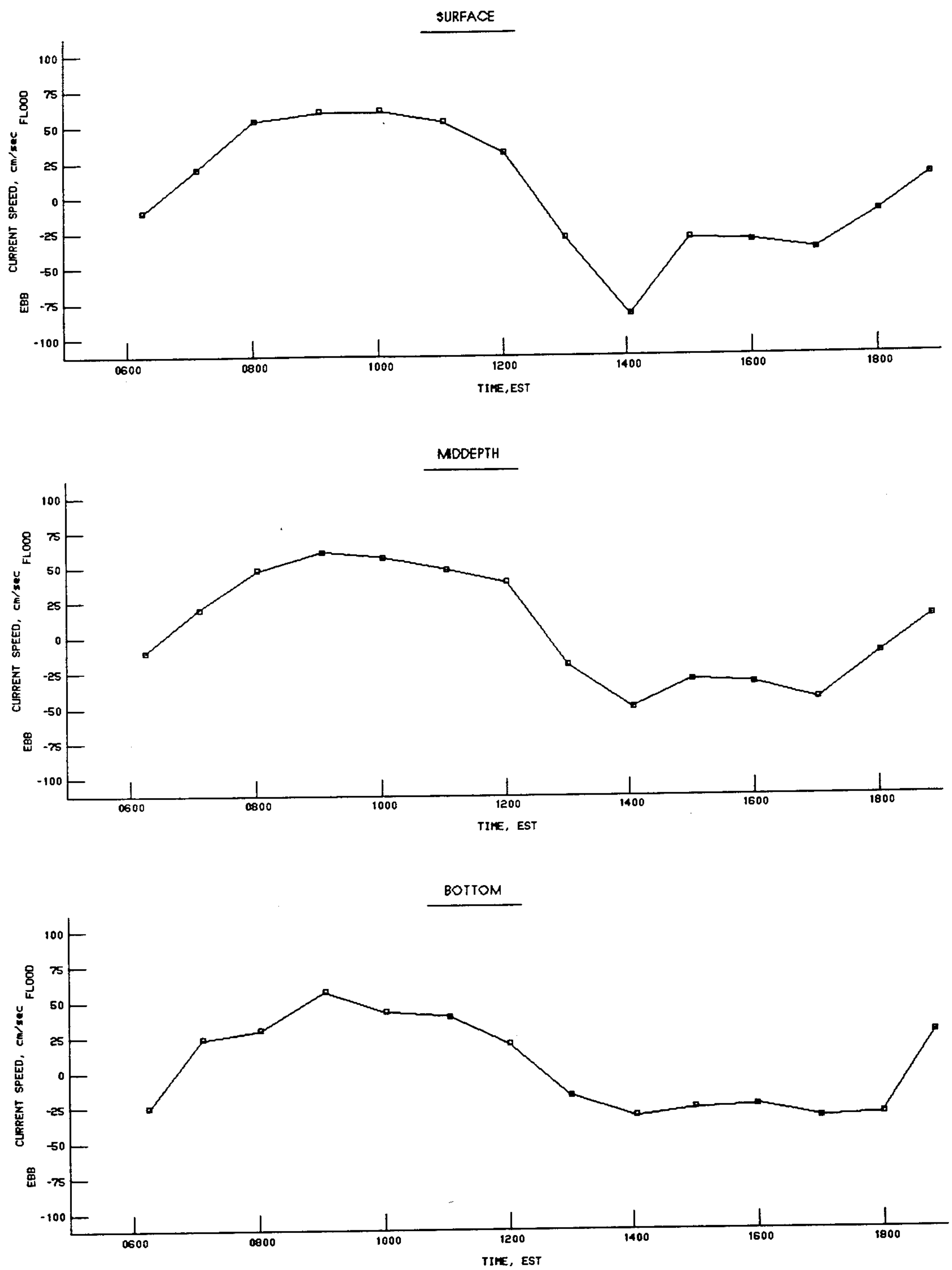
CURRENT SPEED
STATION R6.0 (2500)
THREE-QUARTER DEPTH AND BOTTOM
08/20/93



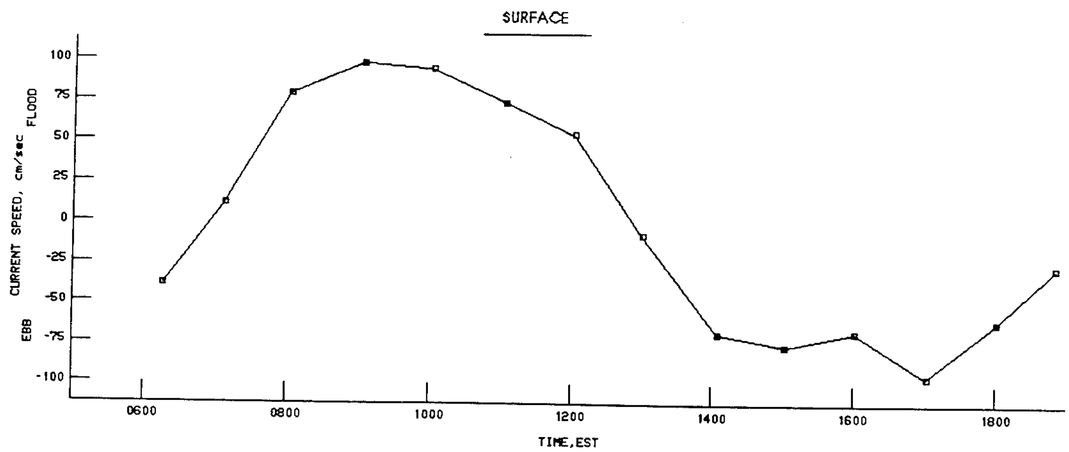


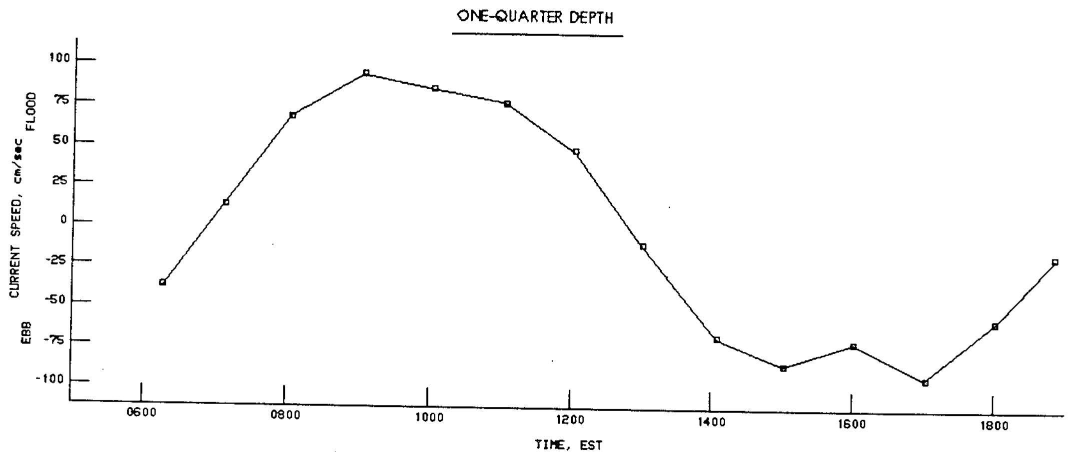


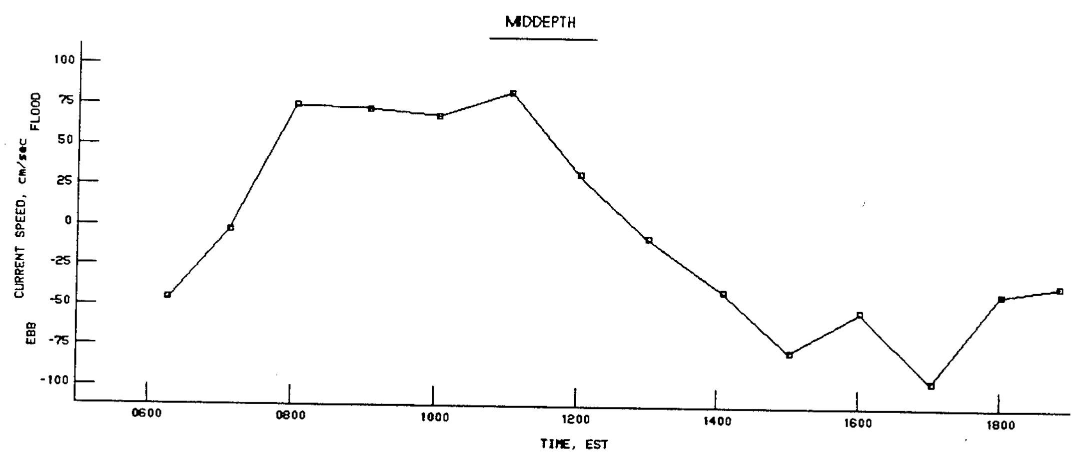
CURRENT SPEED
STATION R6.0 (3000)
SURFACE, MIDDEPTH, AND BOTTOM
08/20/93



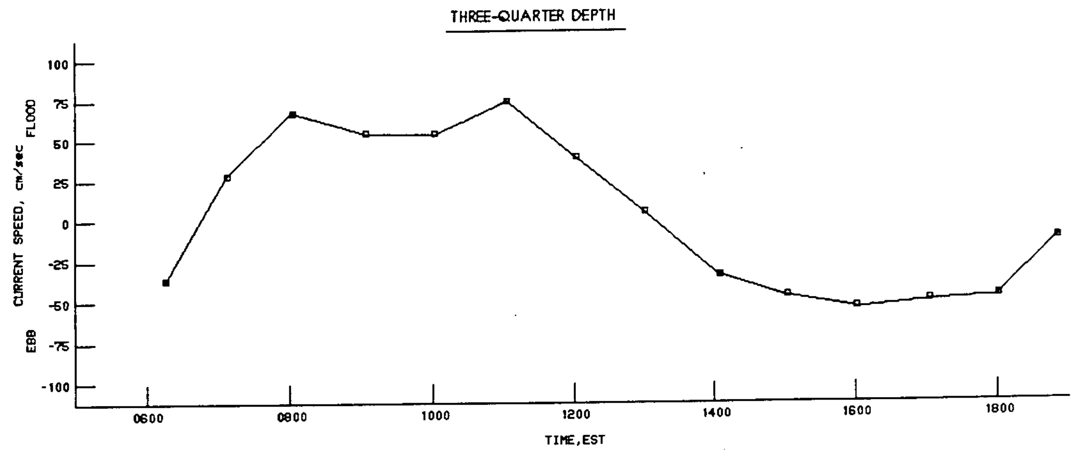
CURRENT SPEED
STATION R7.0 (300)
SURFACE, MIDDEPTH, AND BOTTOM
08/20/93

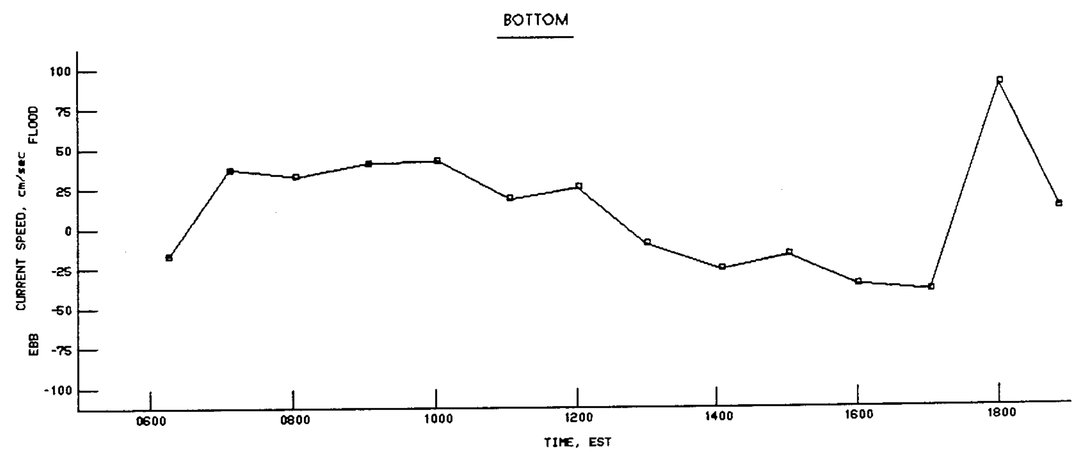




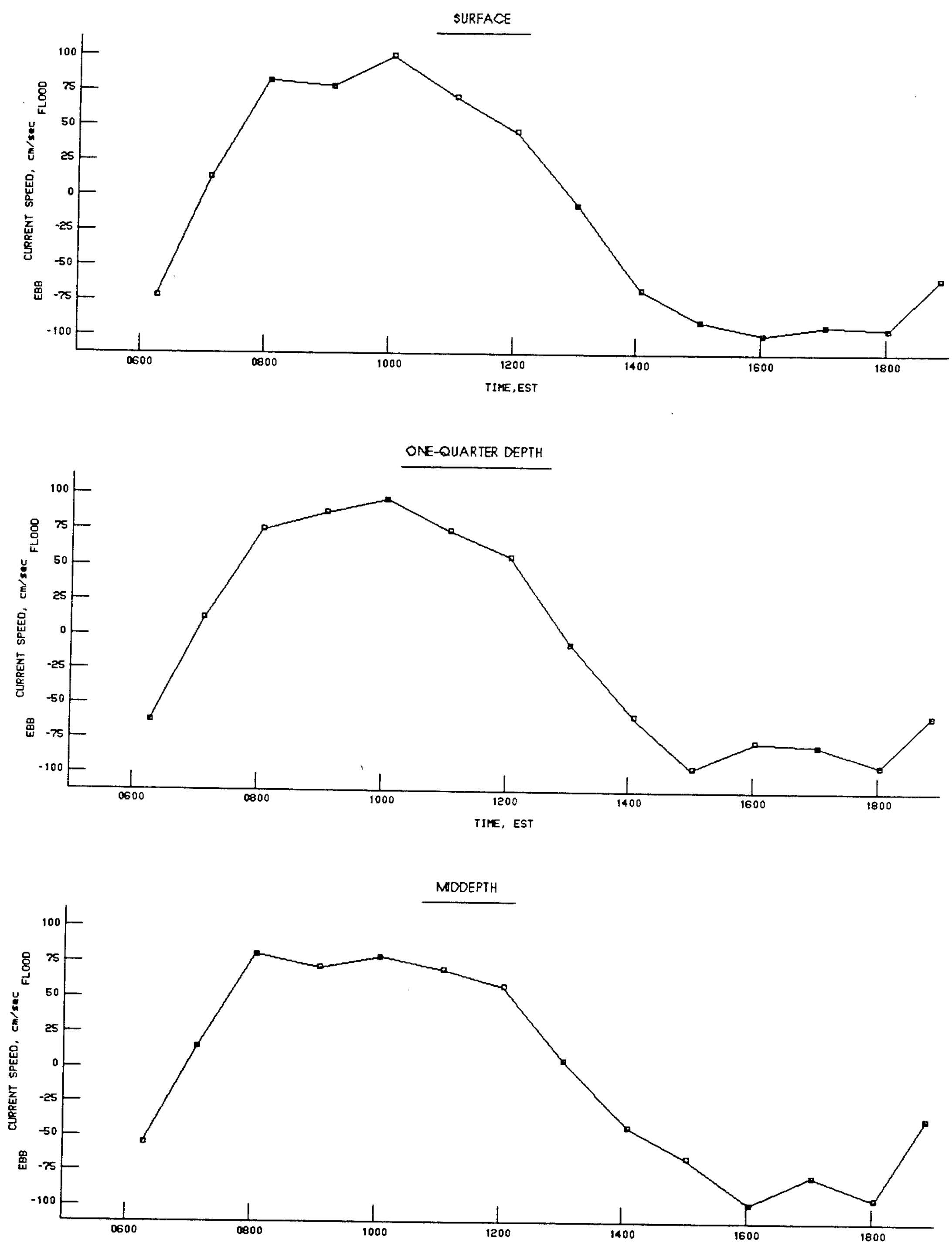


CURRENT SPEED
STATION R7.0 (600)
SURFACE, ONE-QUARTER DEPTH, AND MIDDEPTH
08/20/93



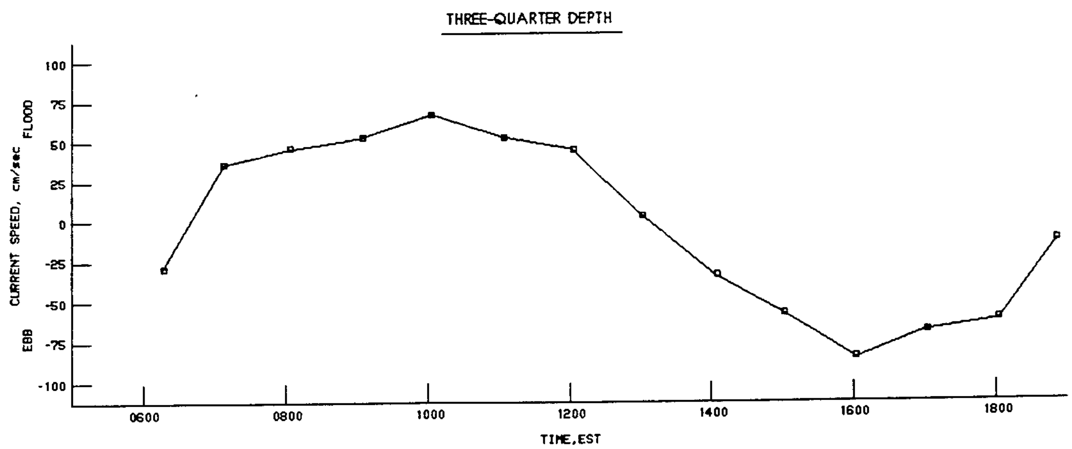


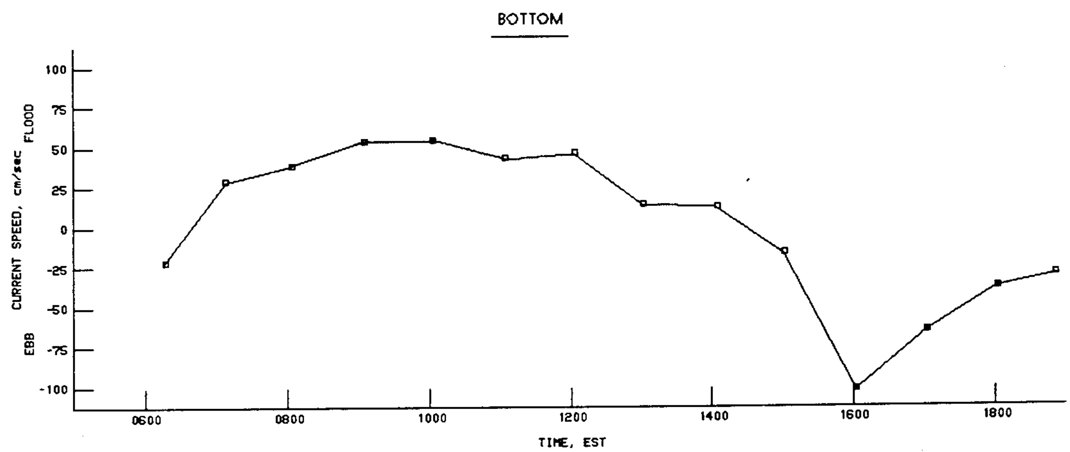
CURRENT SPEED
STATION R7.0 (600)
THREE-QUARTER DEPTH AND BOTTOM
08/20/93



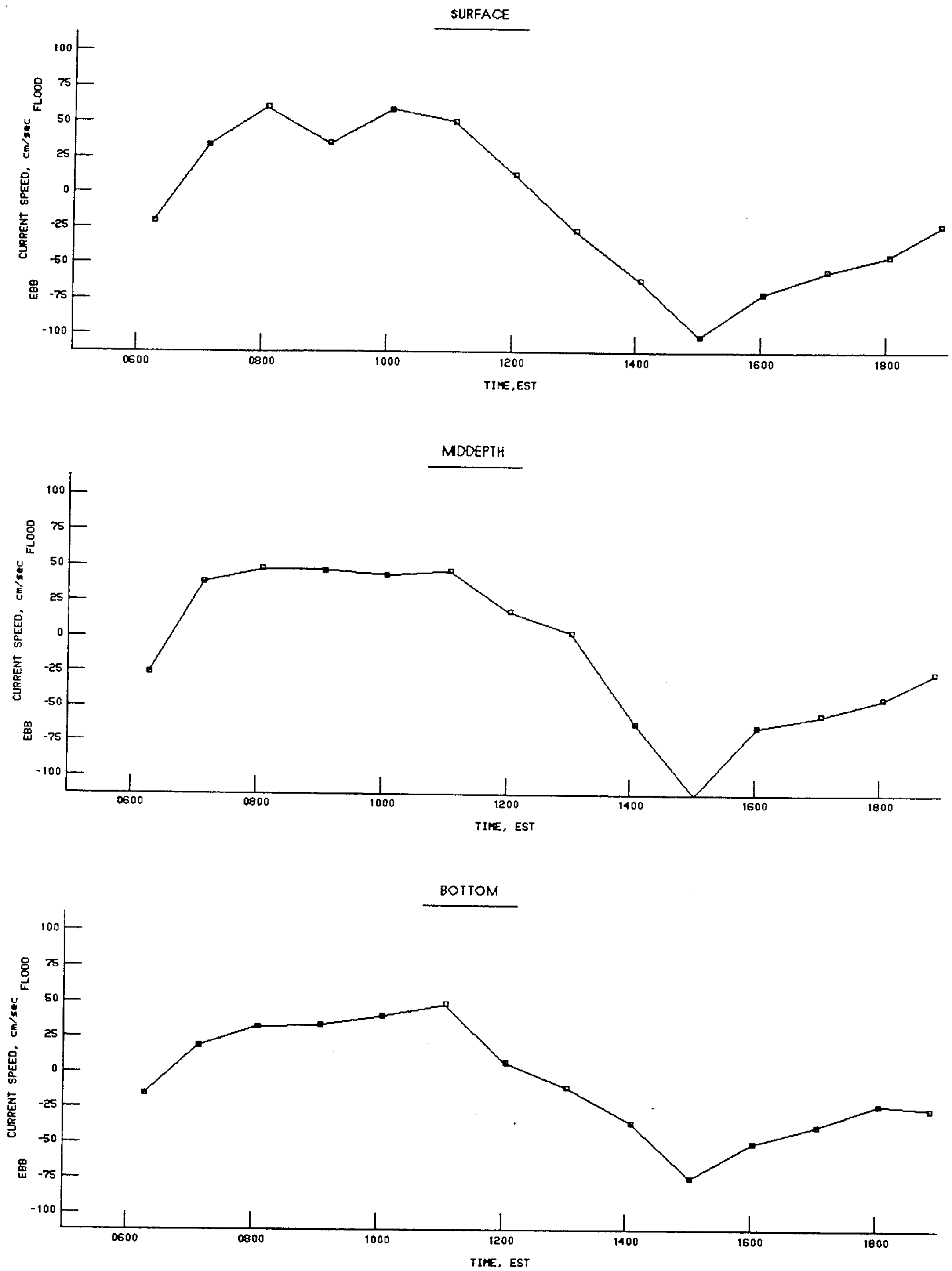
CURRENT SPEED
STATION R7.0 (900)
SURFACE, ONE-QUARTER DEPTH, AND MIDDEPTH
08/20/93

Plate 88



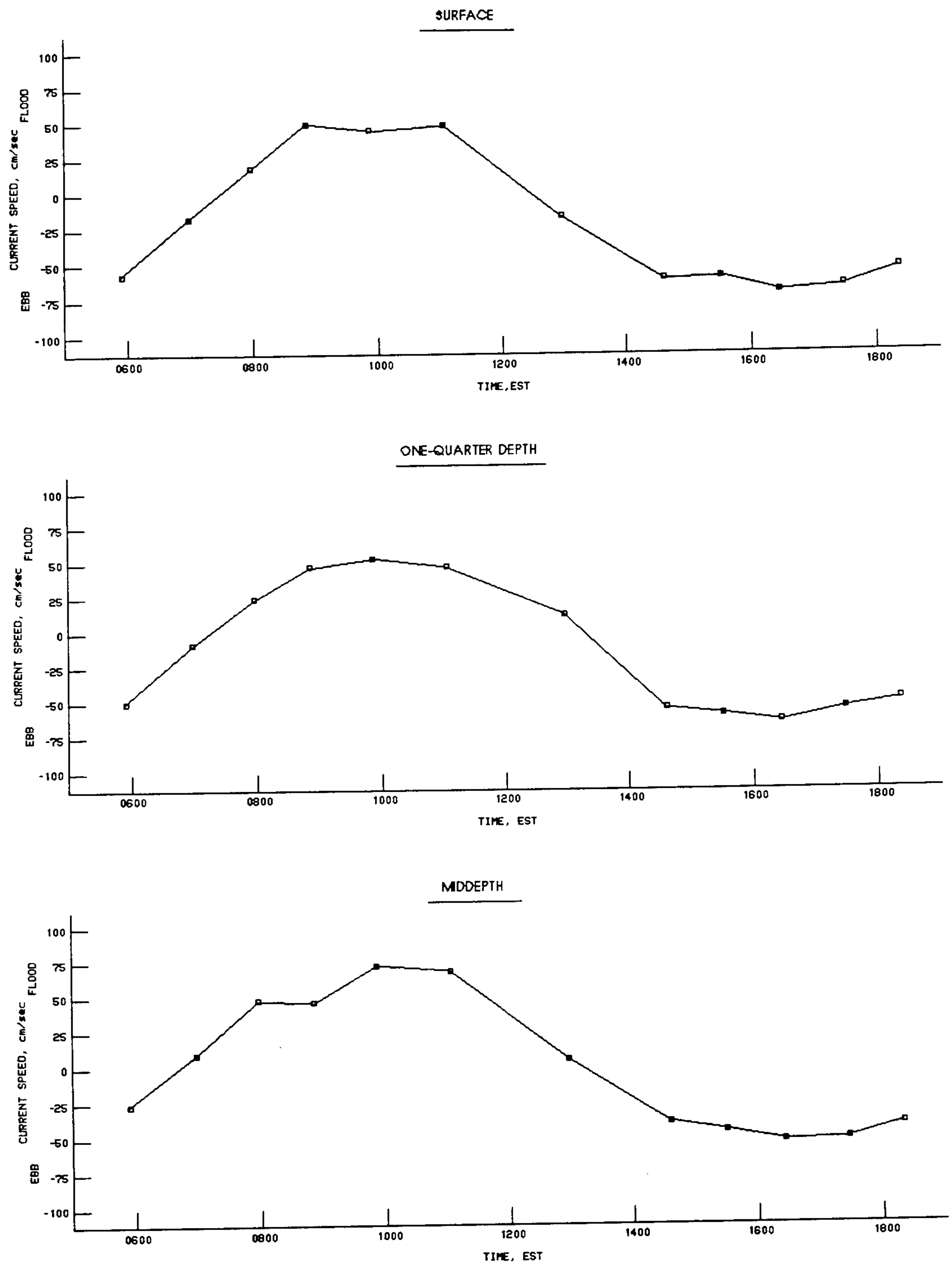


CURRENT SPEED
STATION R7.0 (900)
THREE-QUARTER DEPTH AND BOTTOM
08/20/93

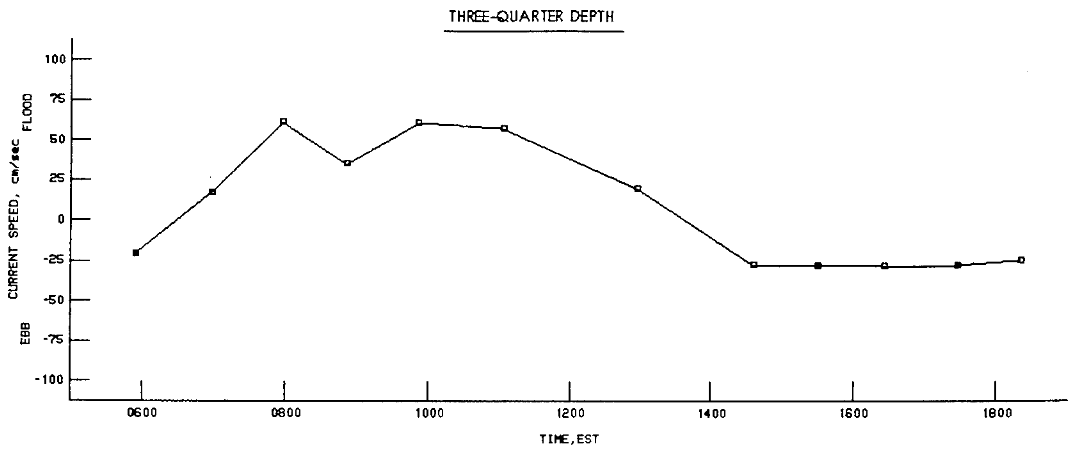


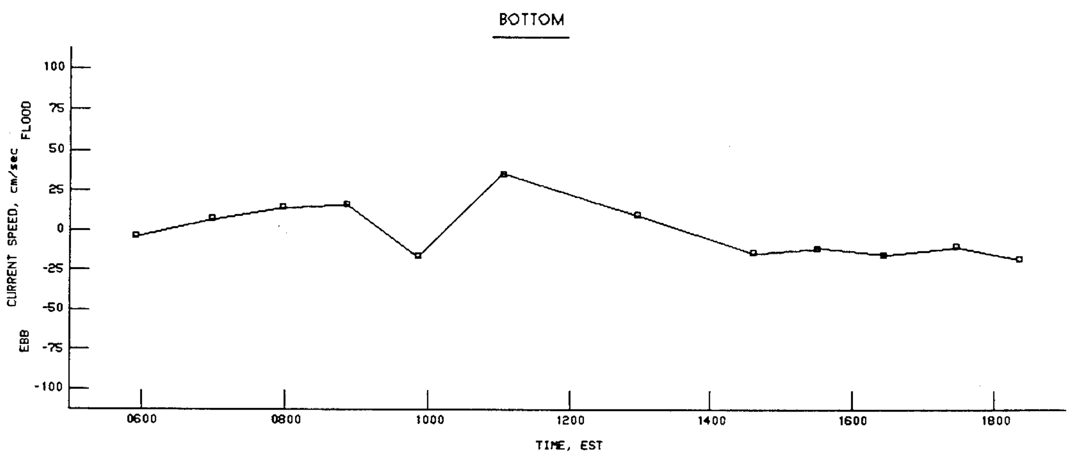
CURRENT SPEED
STATION R7.0 (1200)
SURFACE, MIDDEPTH, AND BOTTOM
08/20/93

Plate 90

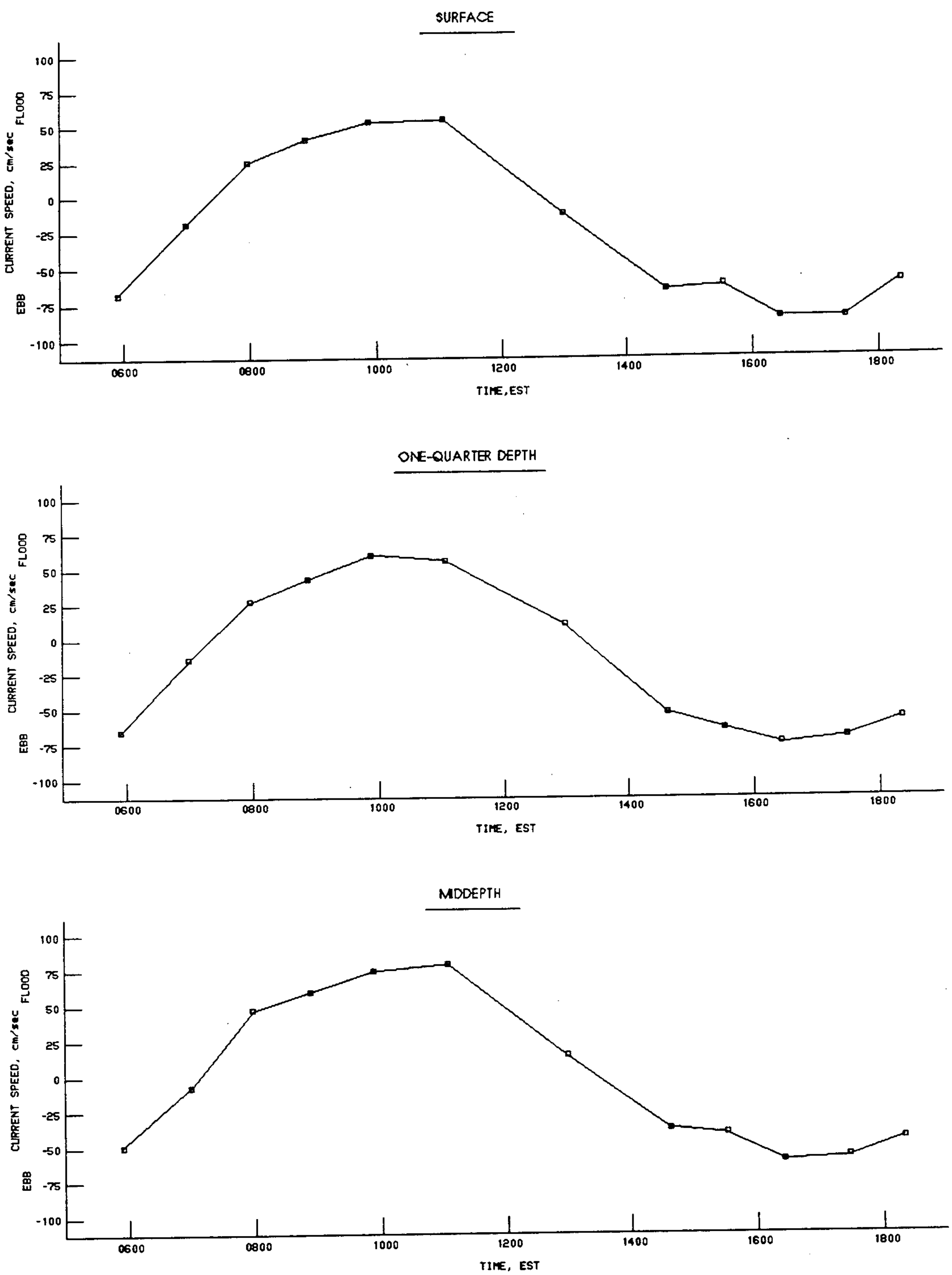


CURRENT SPEED
STATION R8.0 (200)
SURFACE, ONE-QUARTER DEPTH, AND MIDDEPTH
08/20/93

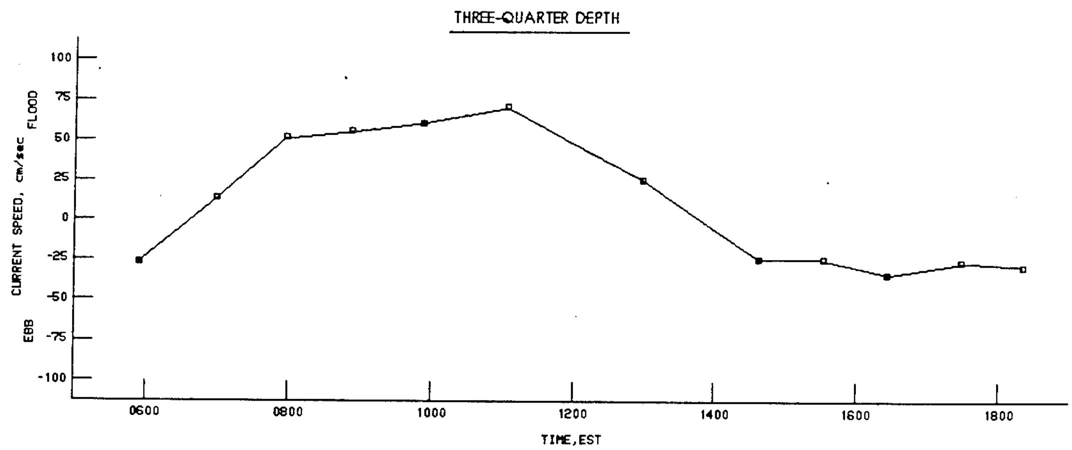


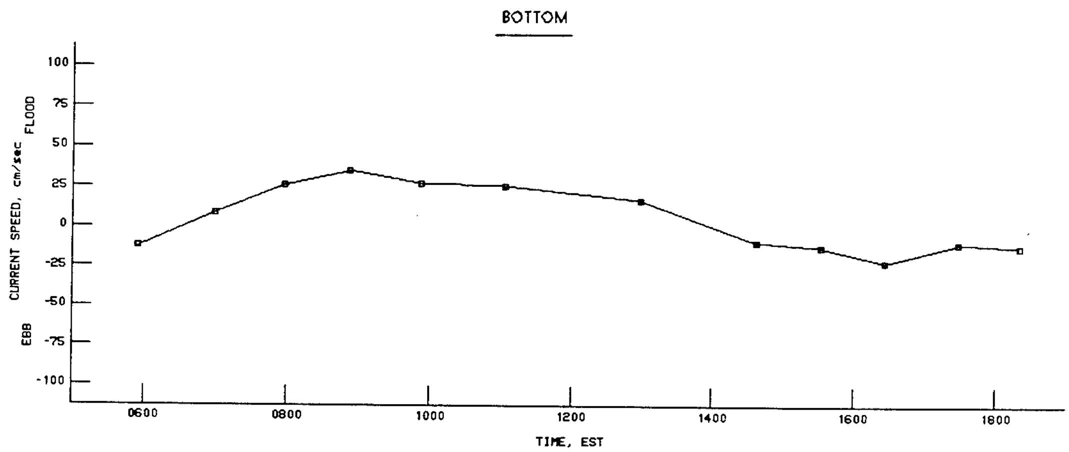


CURRENT SPEED
STATION R8.0 (200)
THREE-QUARTER DEPTH AND BOTTOM
08/20/93

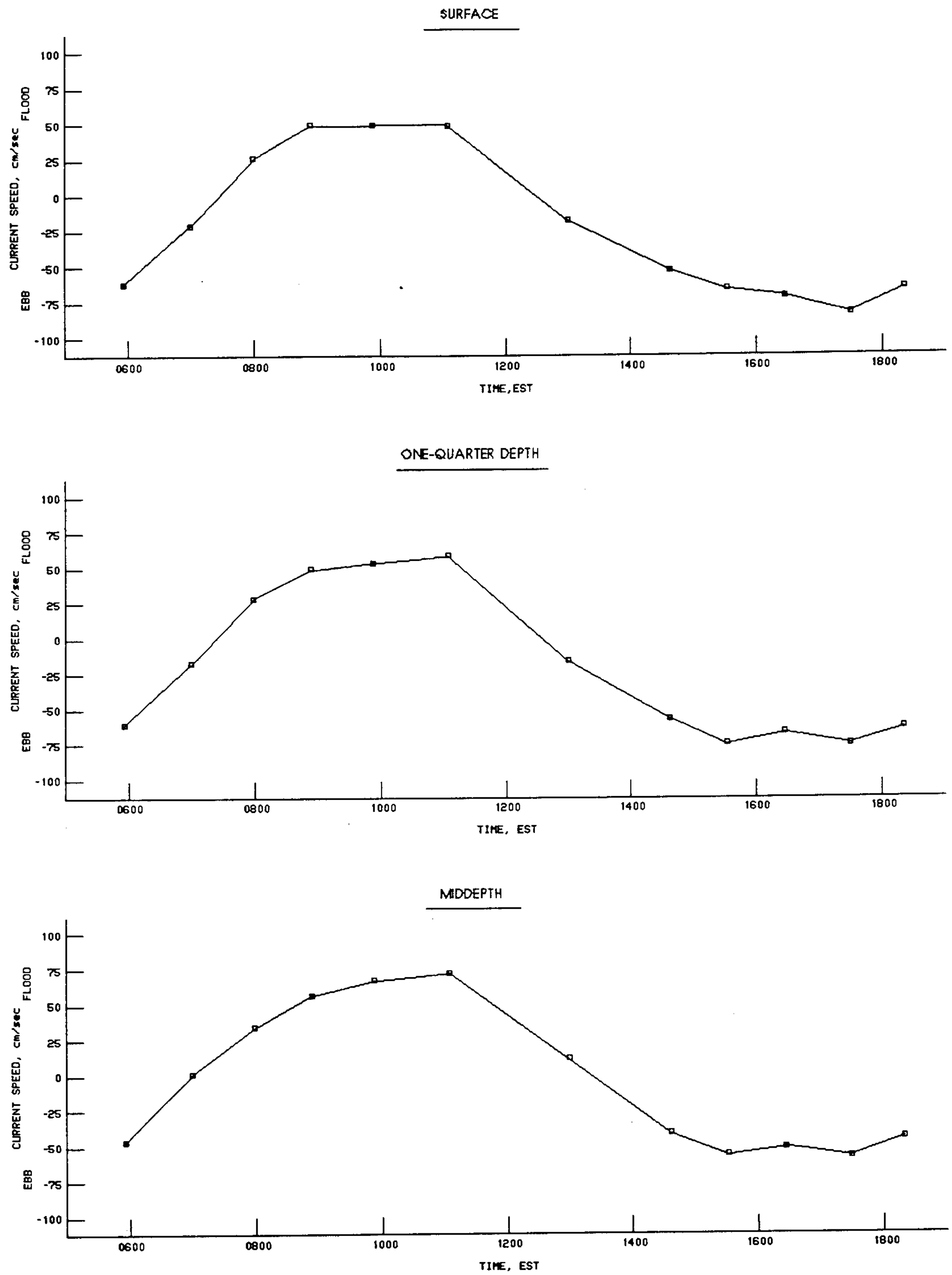


CURRENT SPEED
STATION R8.0 (400)
SURFACE, ONE-QUARTER DEPTH, AND MIDDEPTH
08/20/93

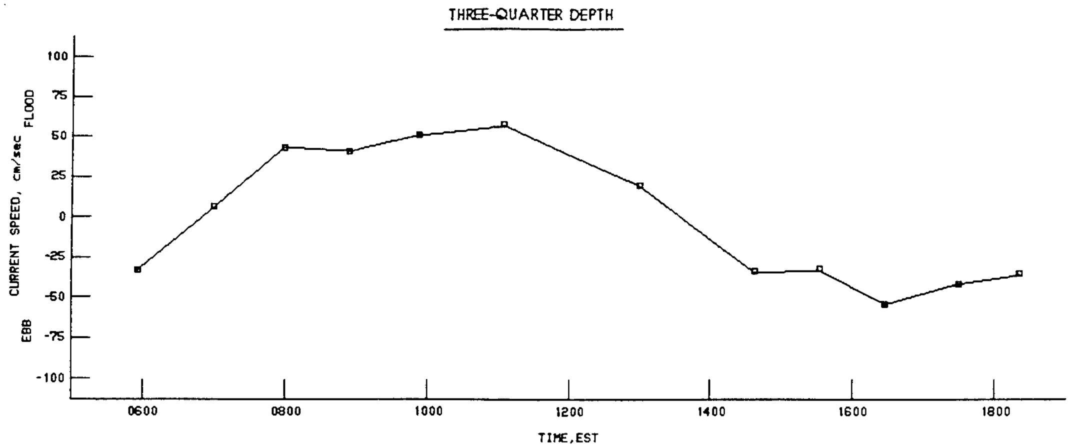


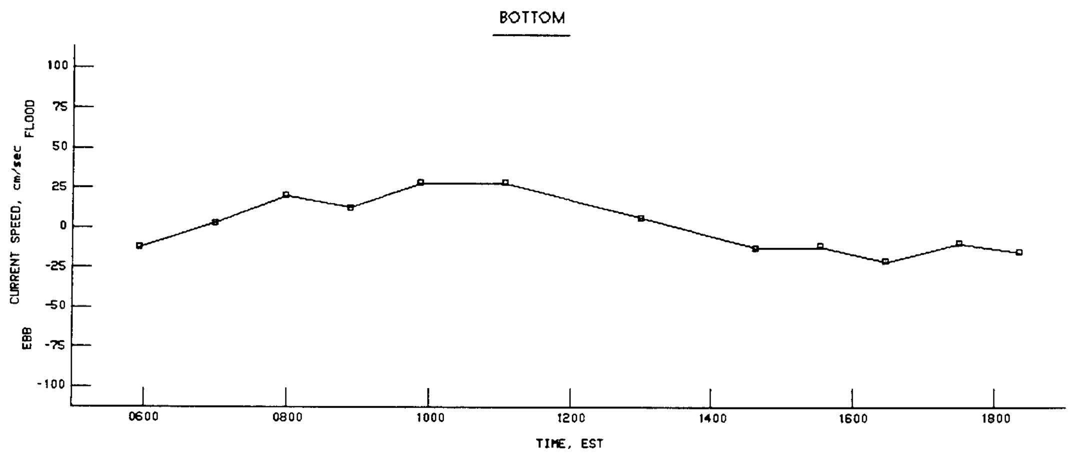


CURRENT SPEED
STATION R8.0 (400)
THREE-QUARTER DEPTH AND BOTTOM
08/20/93

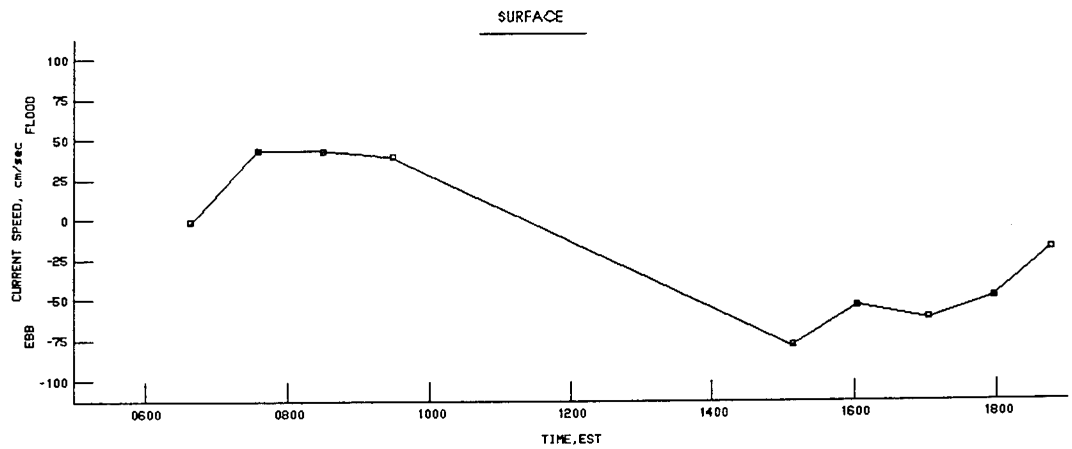


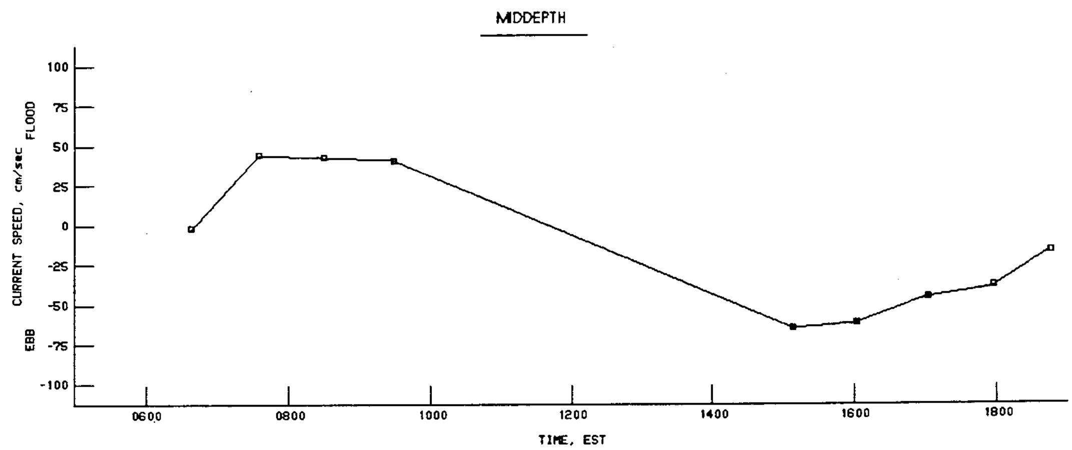
CURRENT SPEED
STATION R8.0 (600)
SURFACE, ONE-QUARTER DEPTH, AND MIDDEPTH
08/20/93

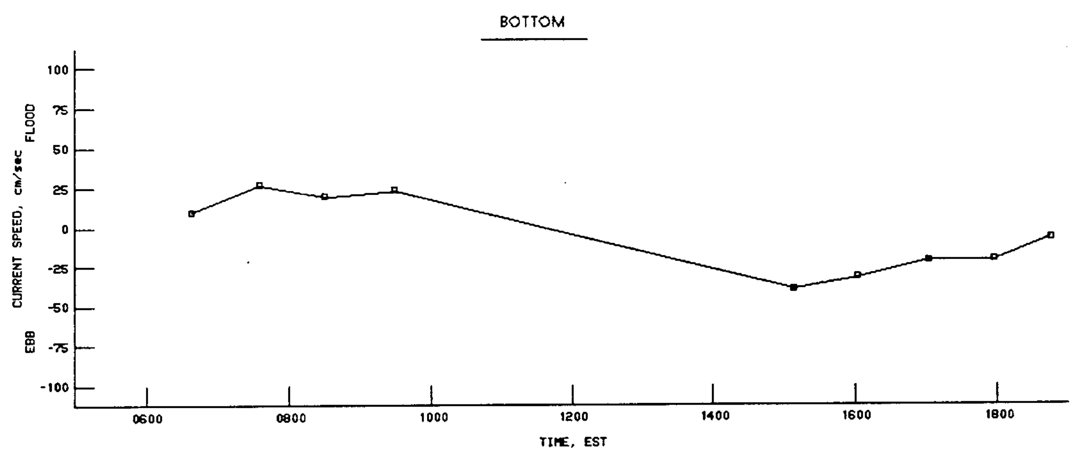




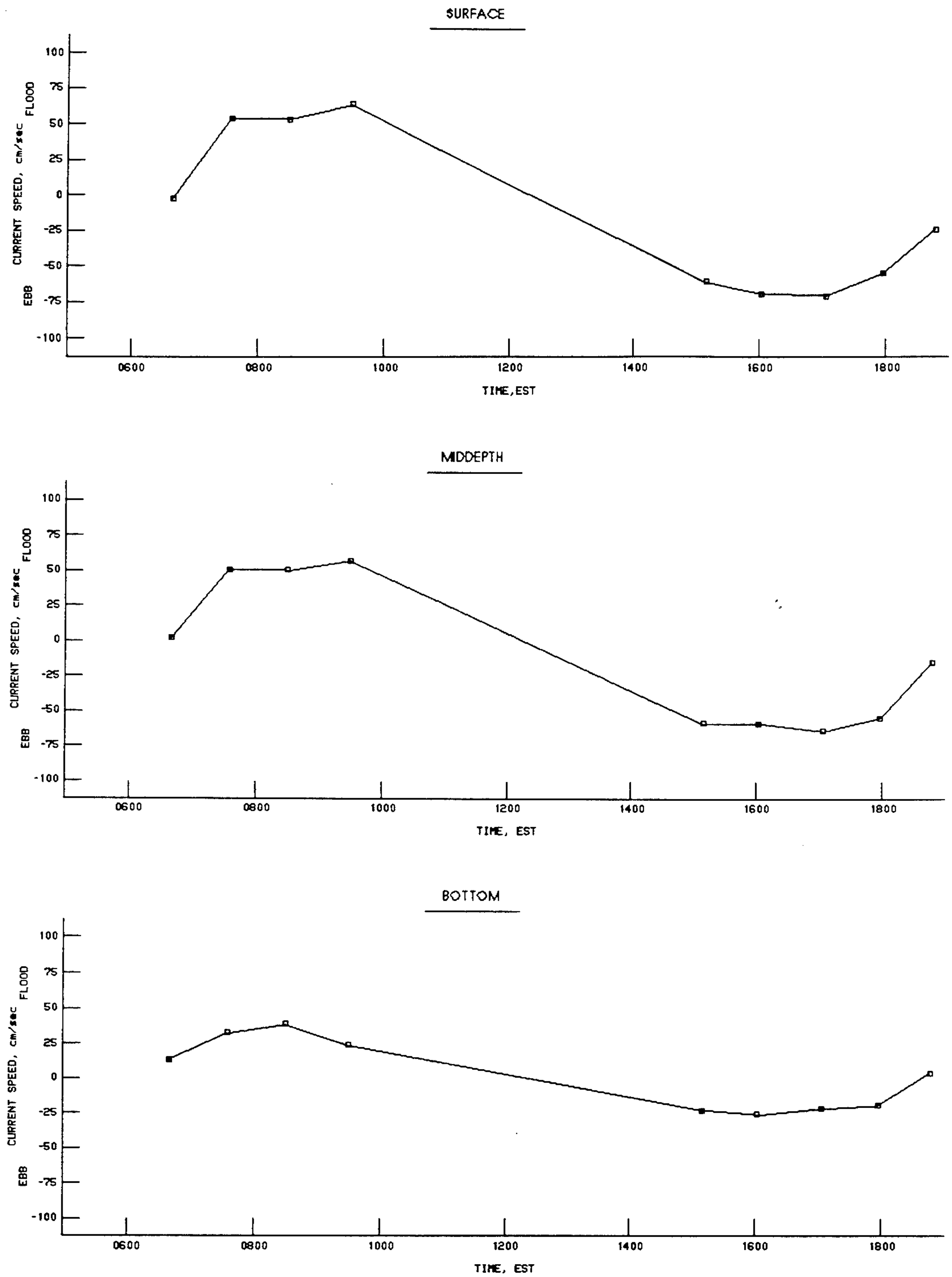
CURRENT SPEED
STATION R8.0 (600)
THREE-QUARTER DEPTH AND BOTTOM
08/20/93



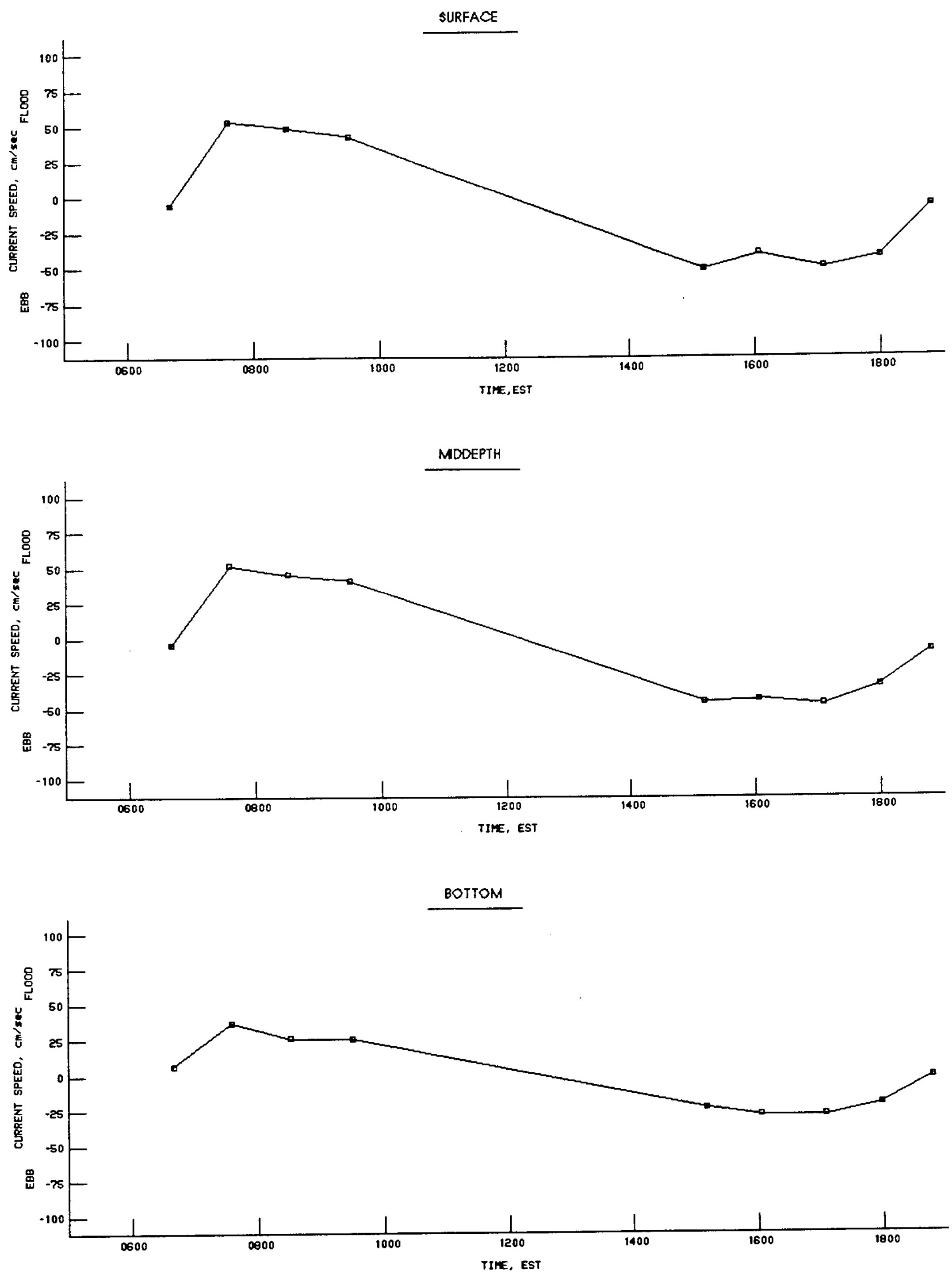




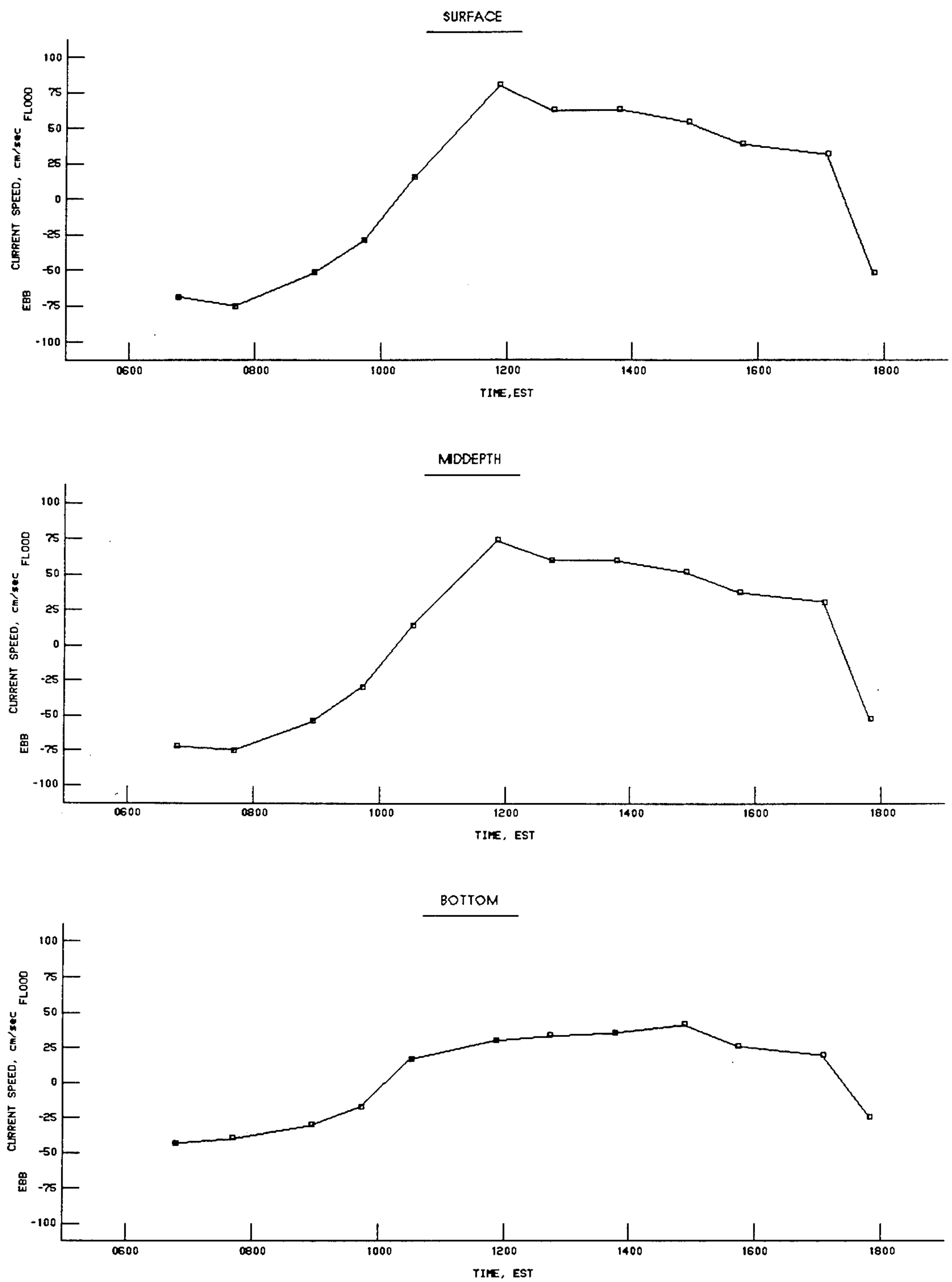
CURRENT SPEED
STATION R11.0 (200)
SURFACE, MIDDEPTH, AND BOTTOM
08/20/93



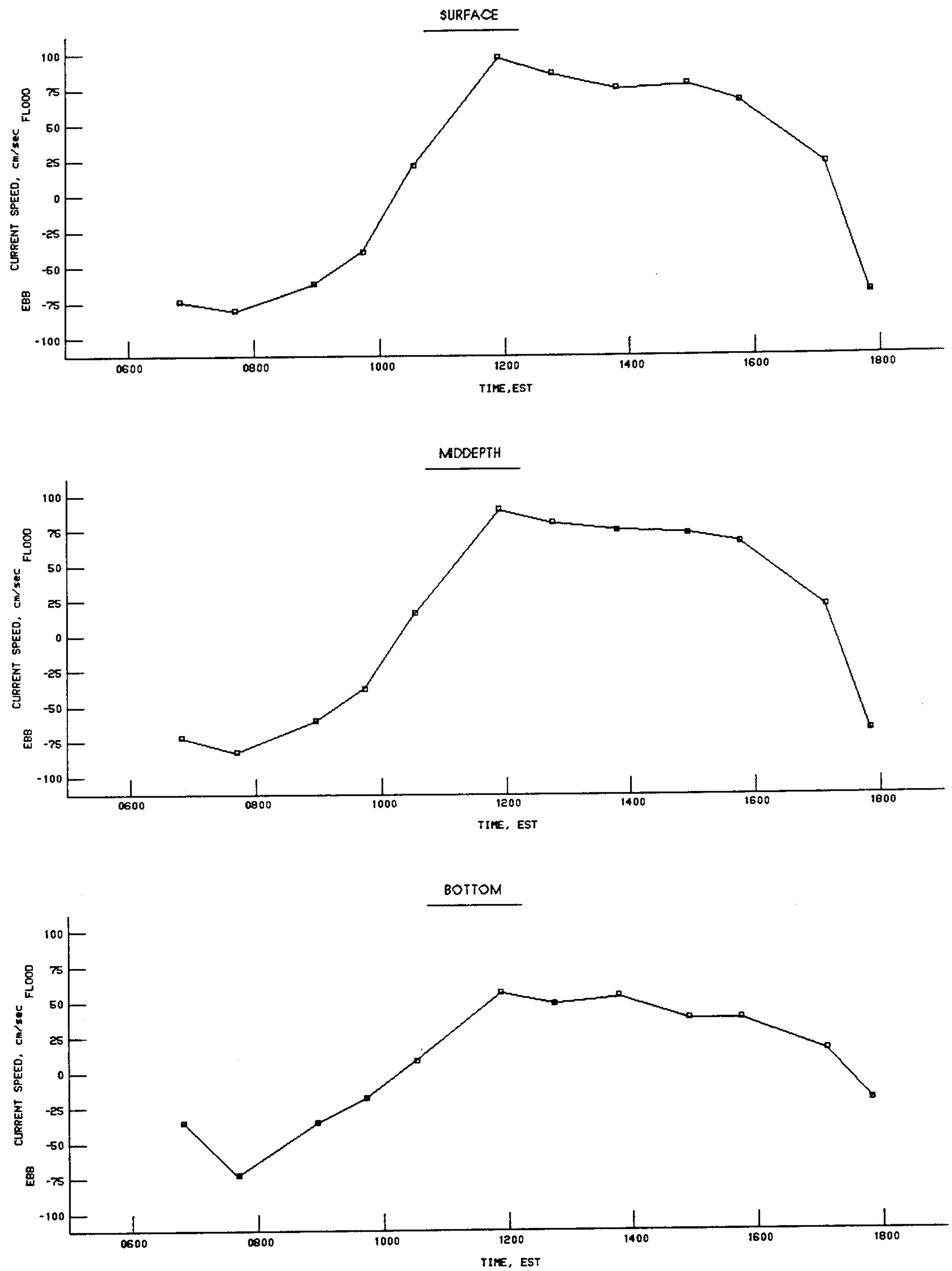
CURRENT SPEED
STATION R11.0 (400)
SURFACE, MIDDEPTH, AND BOTTOM
08/20/93



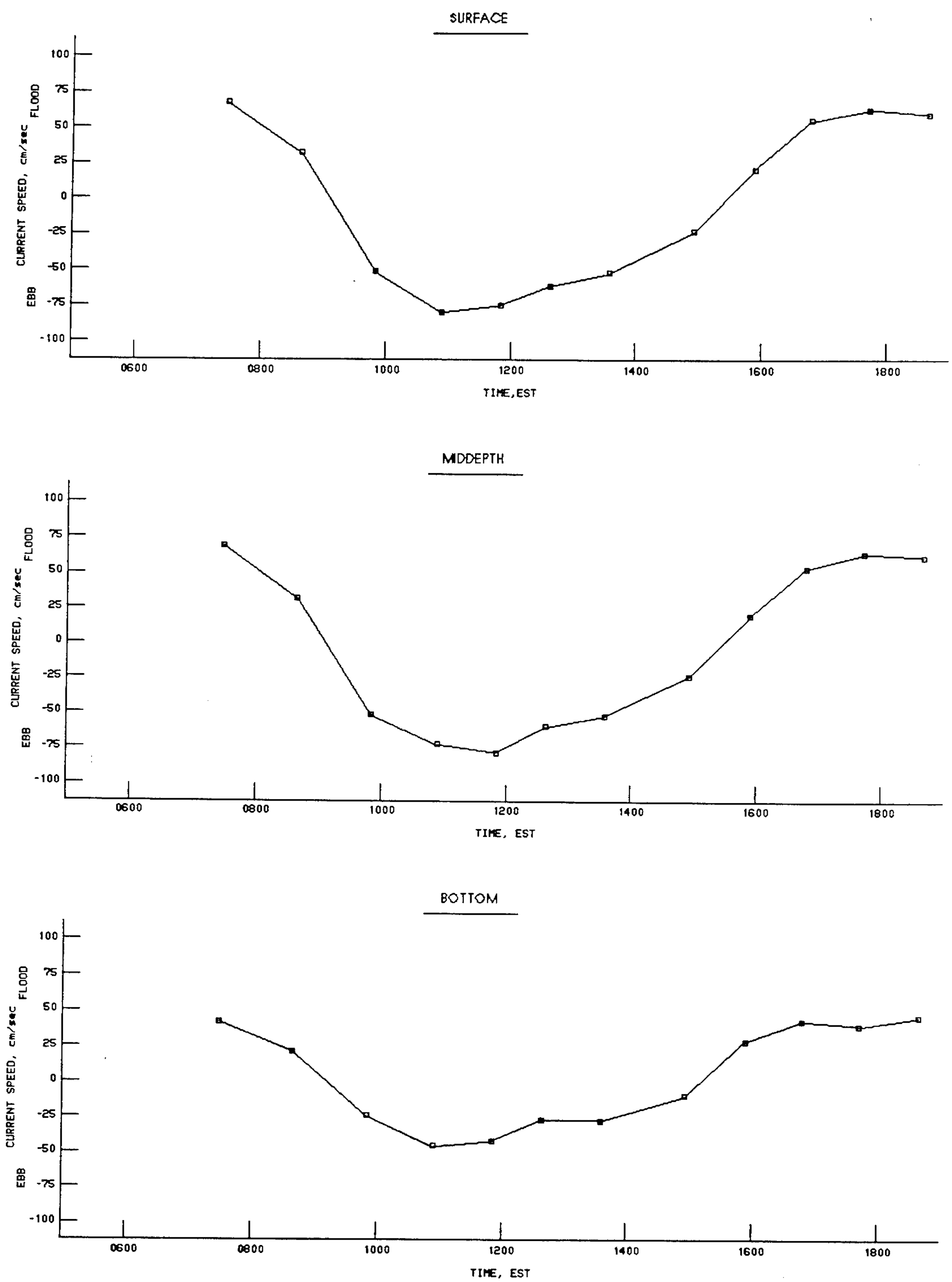
CURRENT SPEED
STATION R11.0 (600)
SURFACE, MIDDEPTH, AND BOTTOM
08/20/93



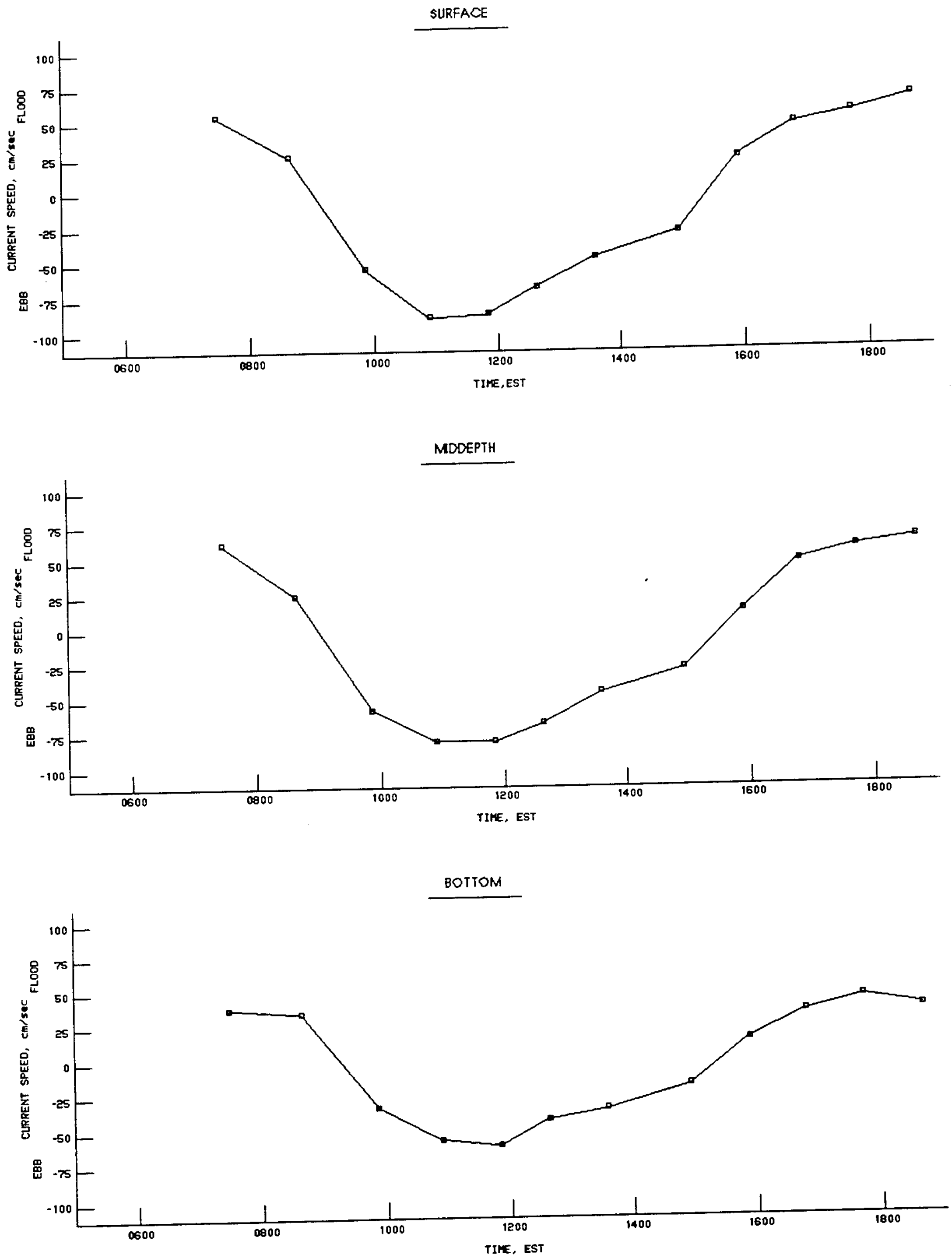
CURRENT SPEED
STATION R12.0 (100)
SURFACE, MIDDEPTH, AND BOTTOM
08/20/93



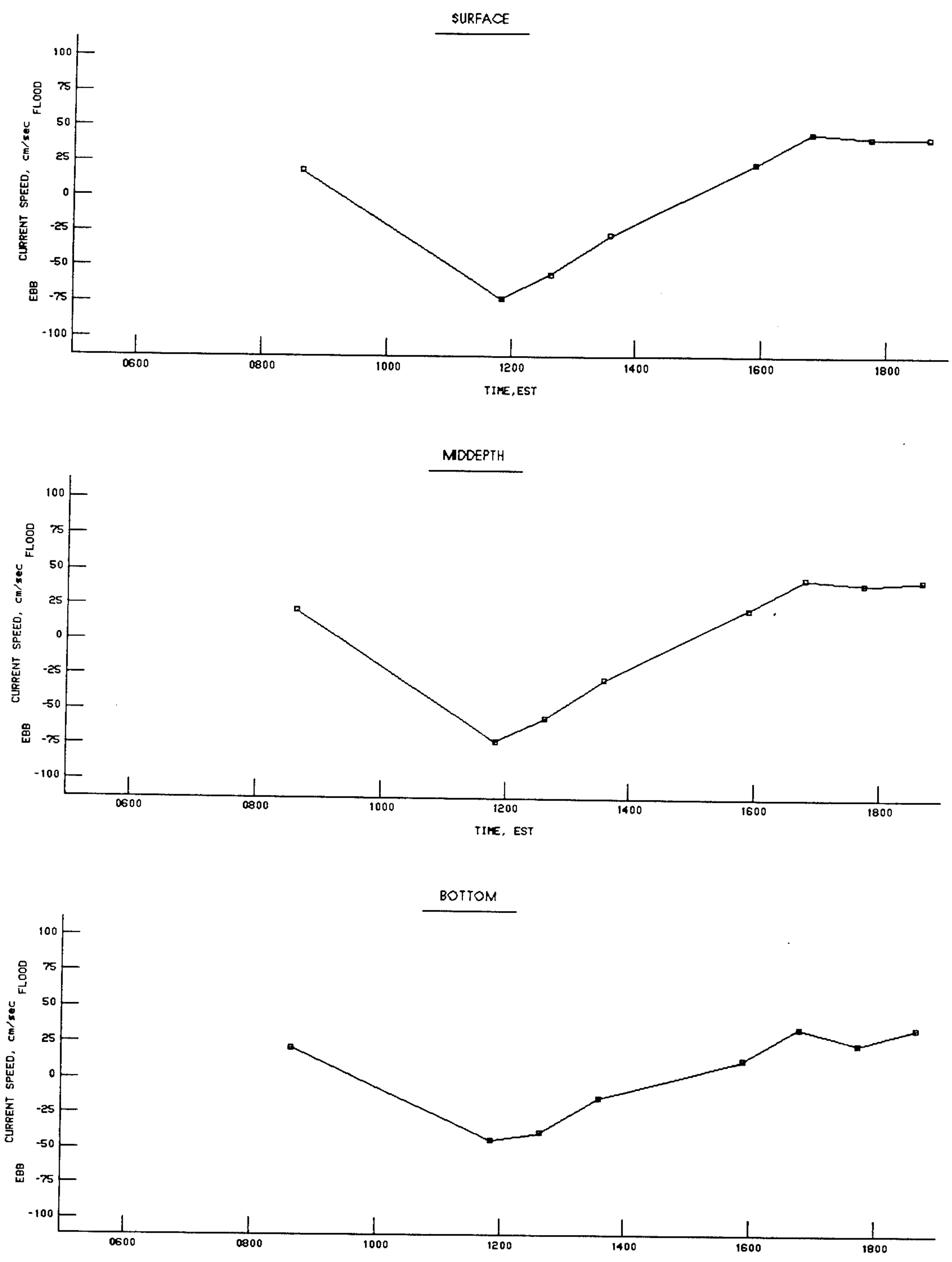
CURRENT SPEED
STATION R12.0 (200)
SURFACE, MIDDEPTH, AND BOTTOM
08/20/93



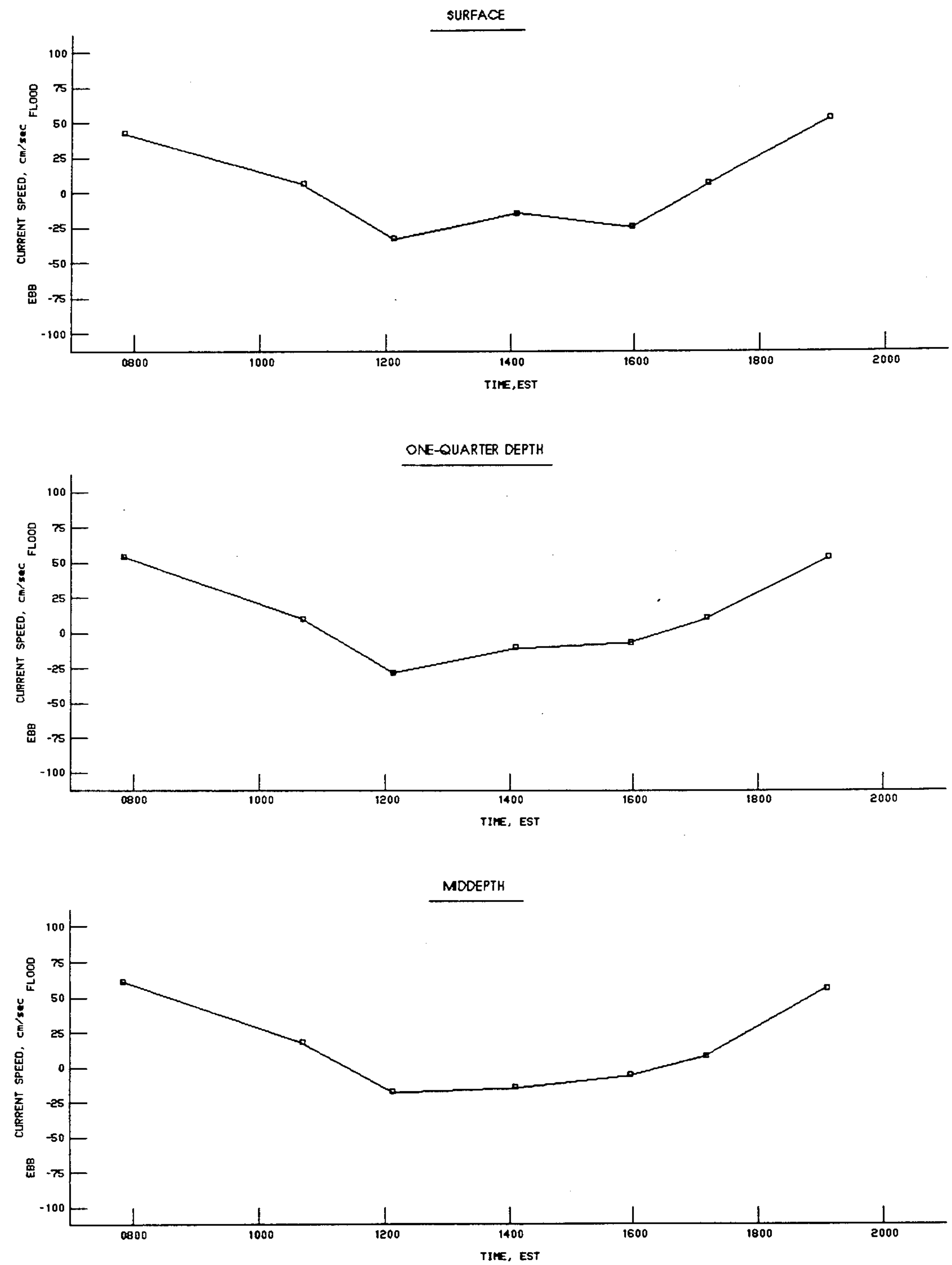
CURRENT SPEED
STATION R13.0 (100)
SURFACE, MIDDEPTH, AND BOTTOM
08/19/93



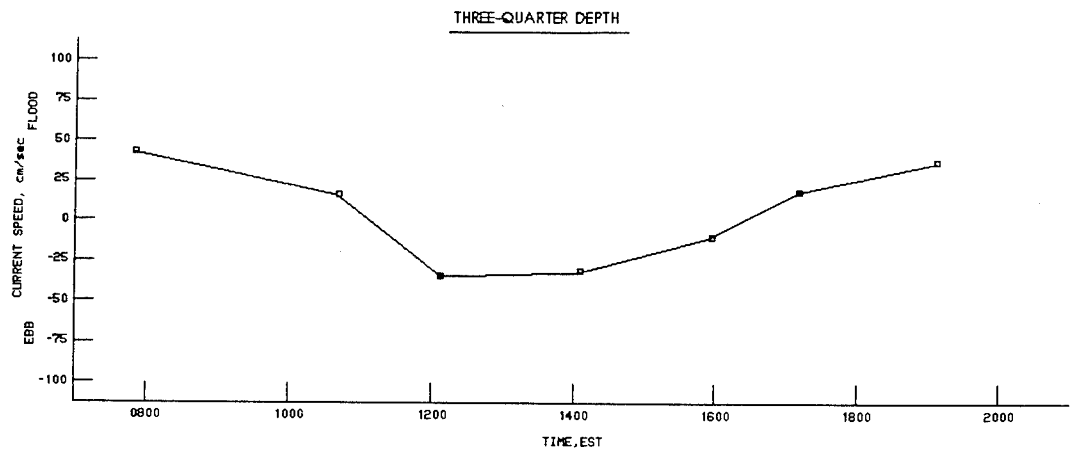
CURRENT SPEED
STATION R13.0 (200)
SURFACE, MIDDEPTH, AND BOTTOM
08/19/93

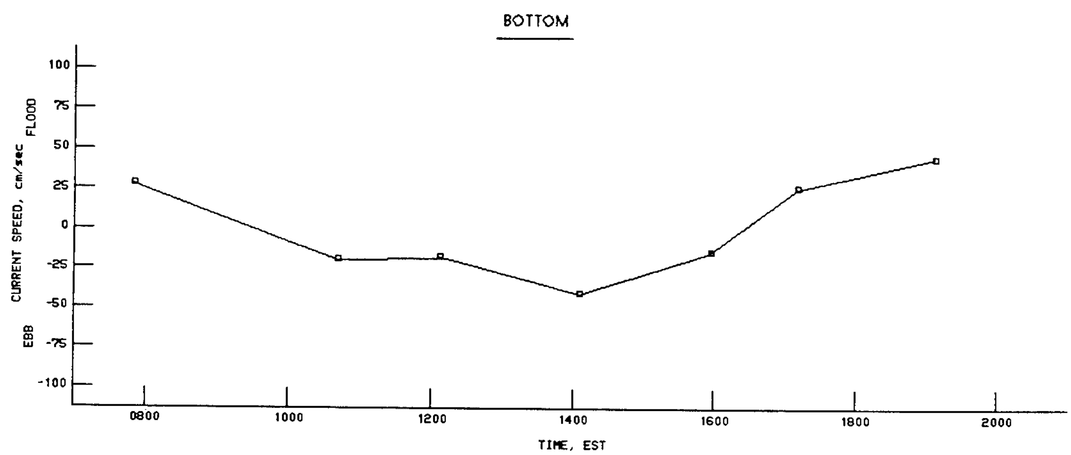


CURRENT SPEED
STATION R13.0 (300)
SURFACE, MIDDEPTH, AND BOTTOM
08/19/93

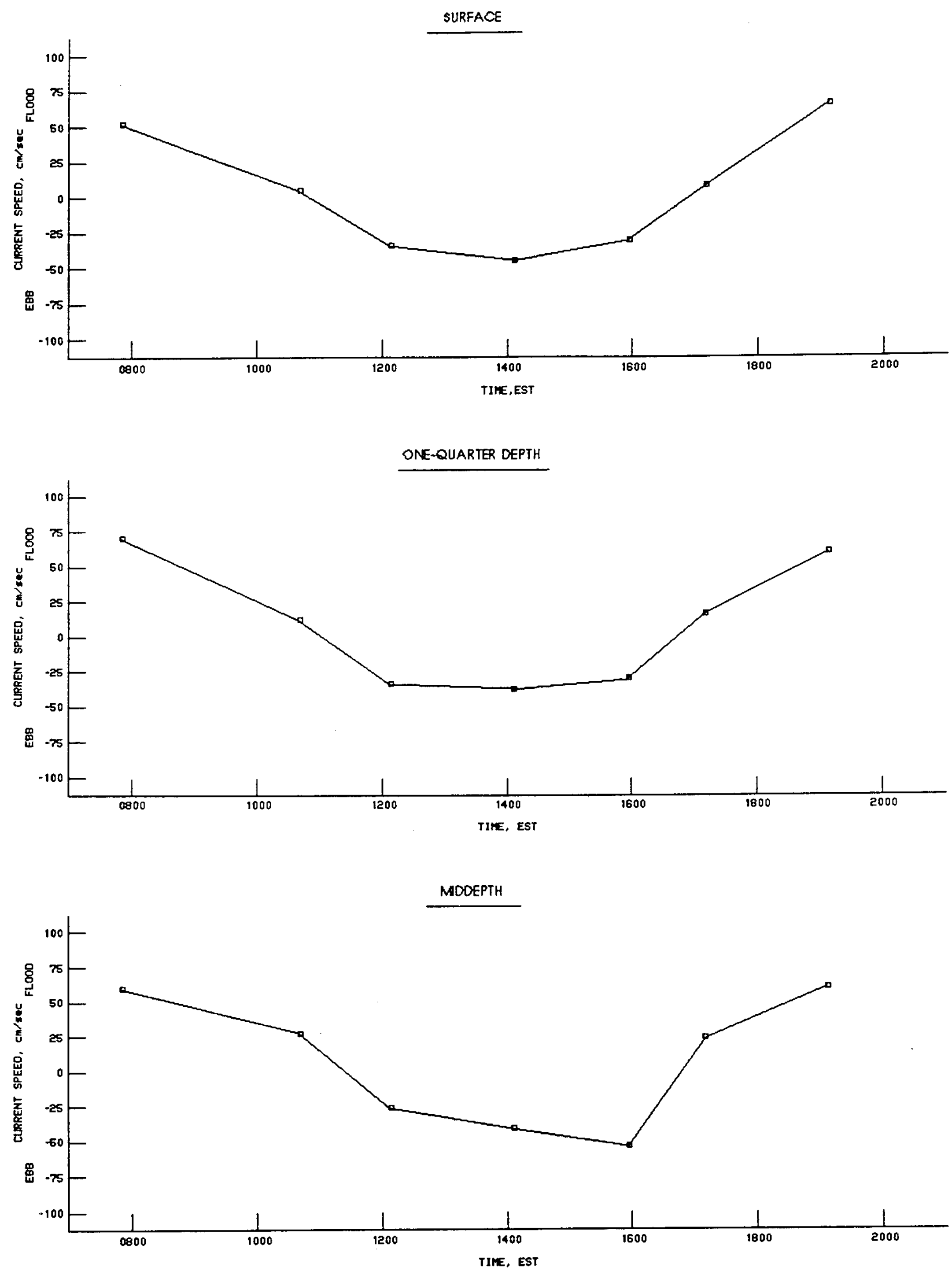


CURRENT SPEED
STATION RCB-2 (900)
SURFACE, ONE-QUARTER DEPTH, AND MIDDEPTH
08/19/93

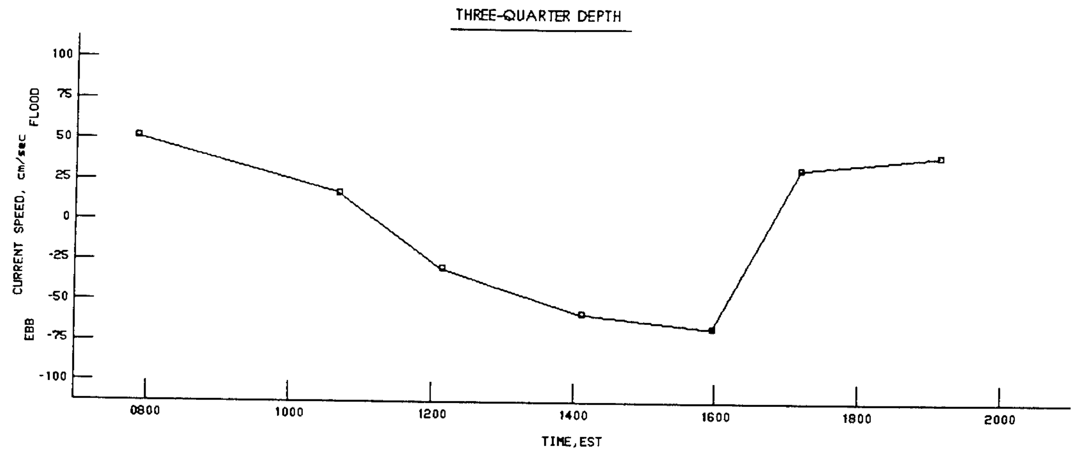


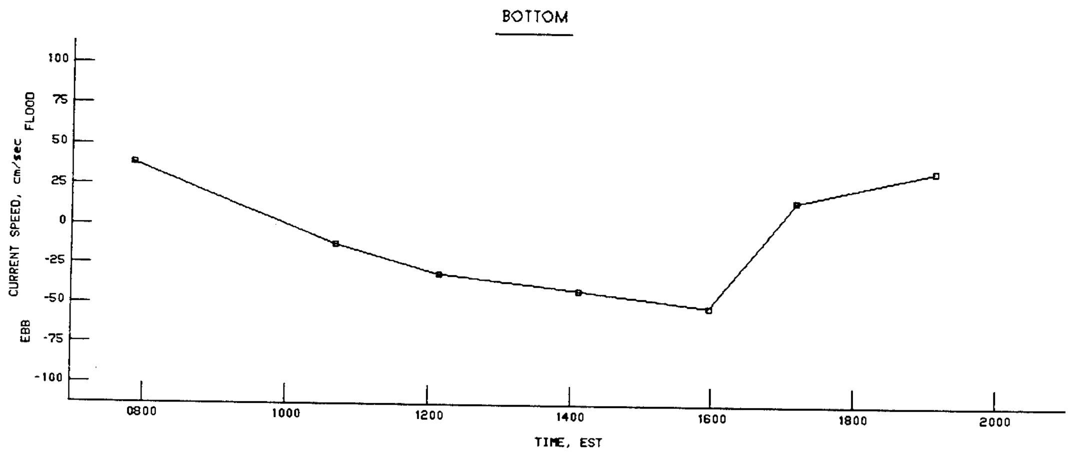


CURRENT SPEED
STATION RCB-2 (900)
THREE-QUARTER DEPTH AND BOTTOM
08/19/93

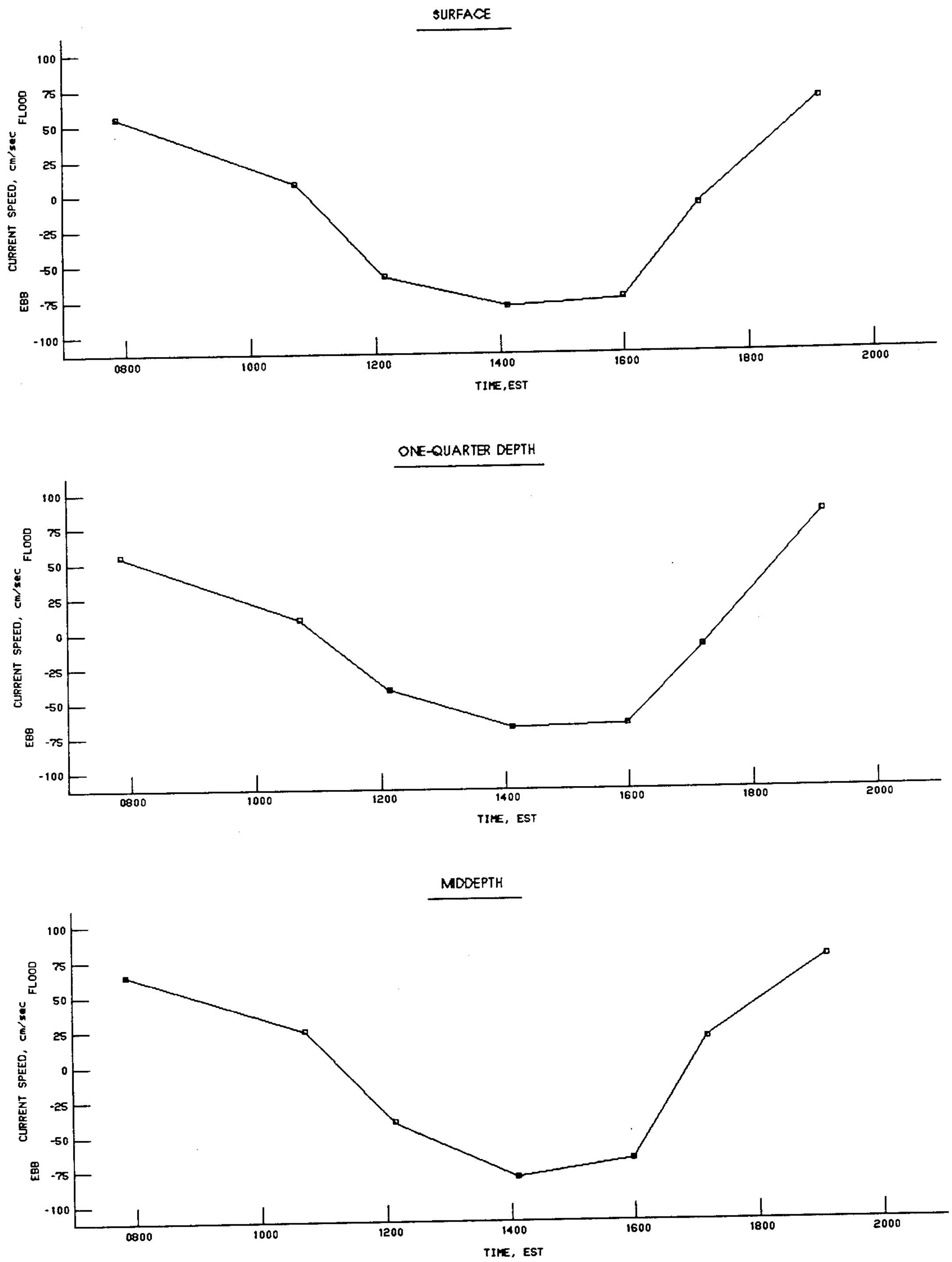


CURRENT SPEED
STATION RCB-2 (1100)
SURFACE, ONE-QUARTER DEPTH, AND MIDDEPTH
08/19/93

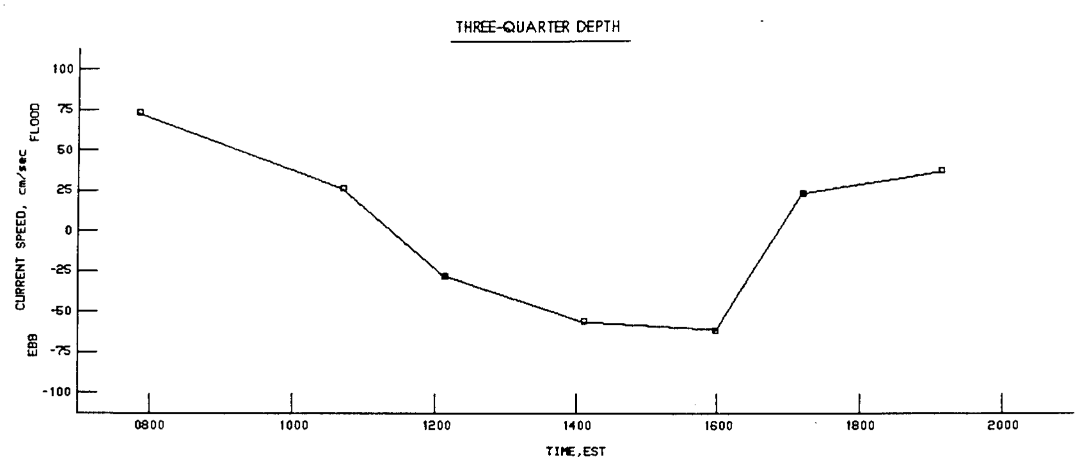


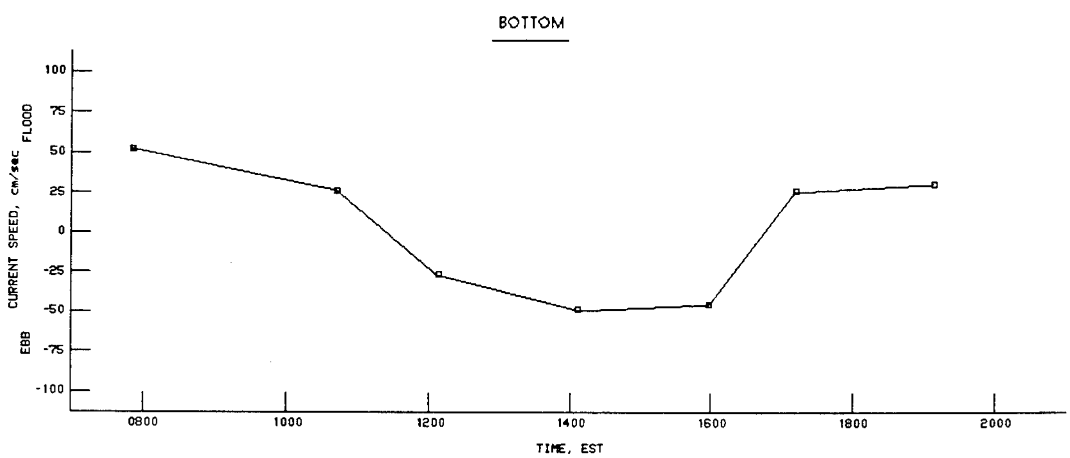


CURRENT SPEED
STATION RCB-2 (1100)
THREE-QUARTER DEPTH AND BOTTOM
08/19/93

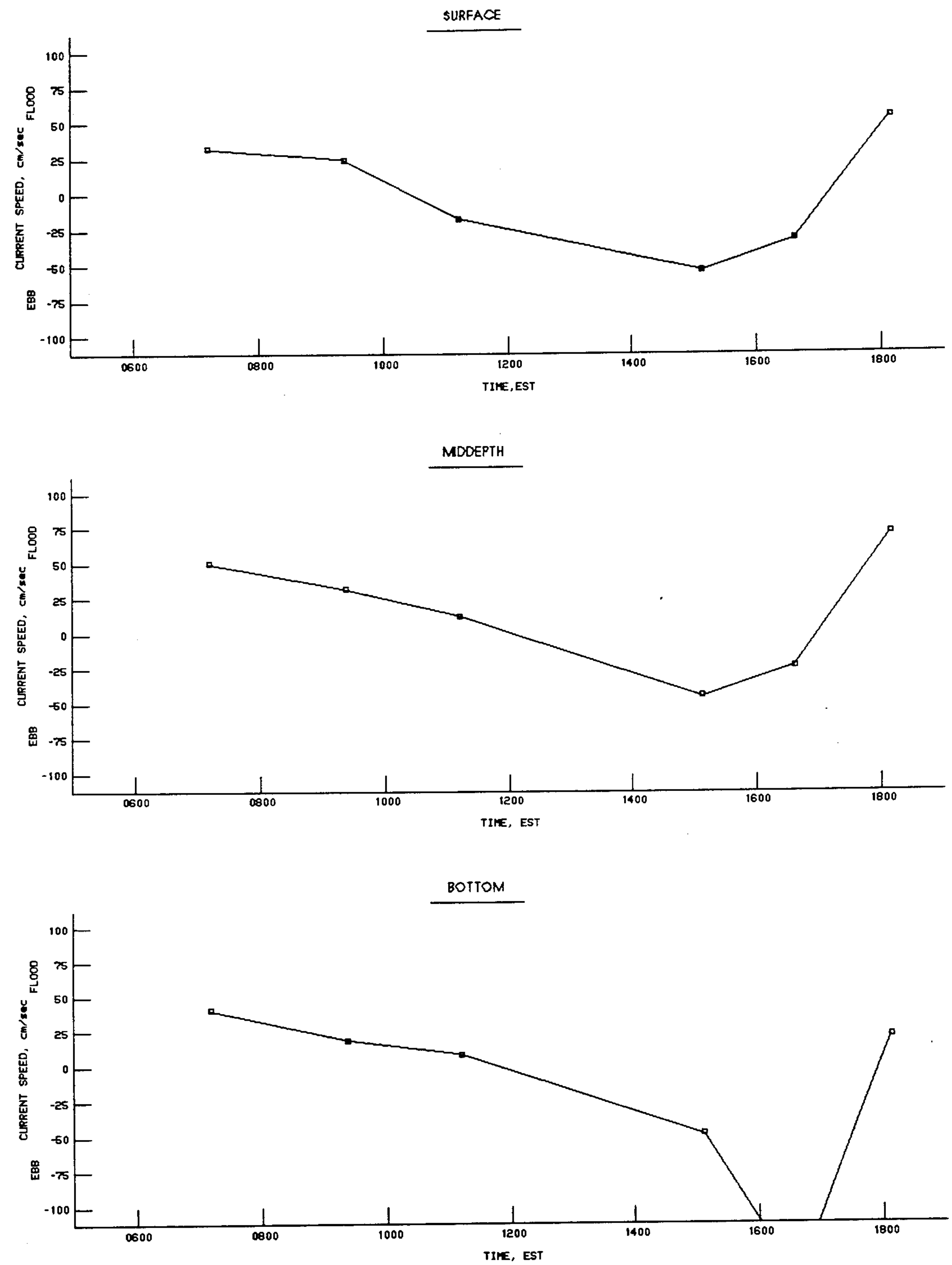


CURRENT SPEED
STATION RCB-2 (1300)
SURFACE, ONE-QUARTER DEPTH, AND MIDDEPTH
08/19/93

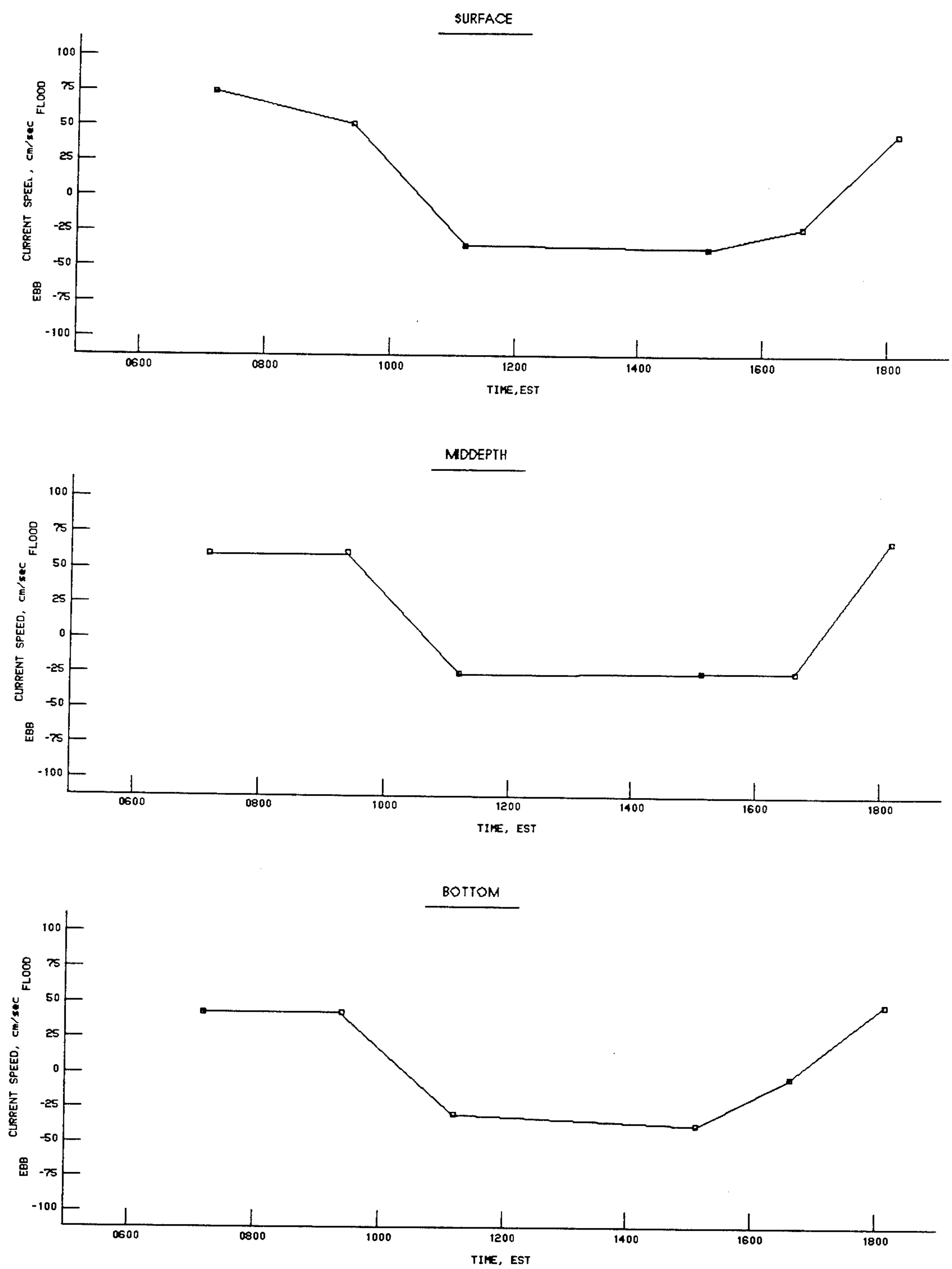




CURRENT SPEED
STATION RCB-2 (1300)
THREE-QUARTER DEPTH AND BOTTOM
08/19/93

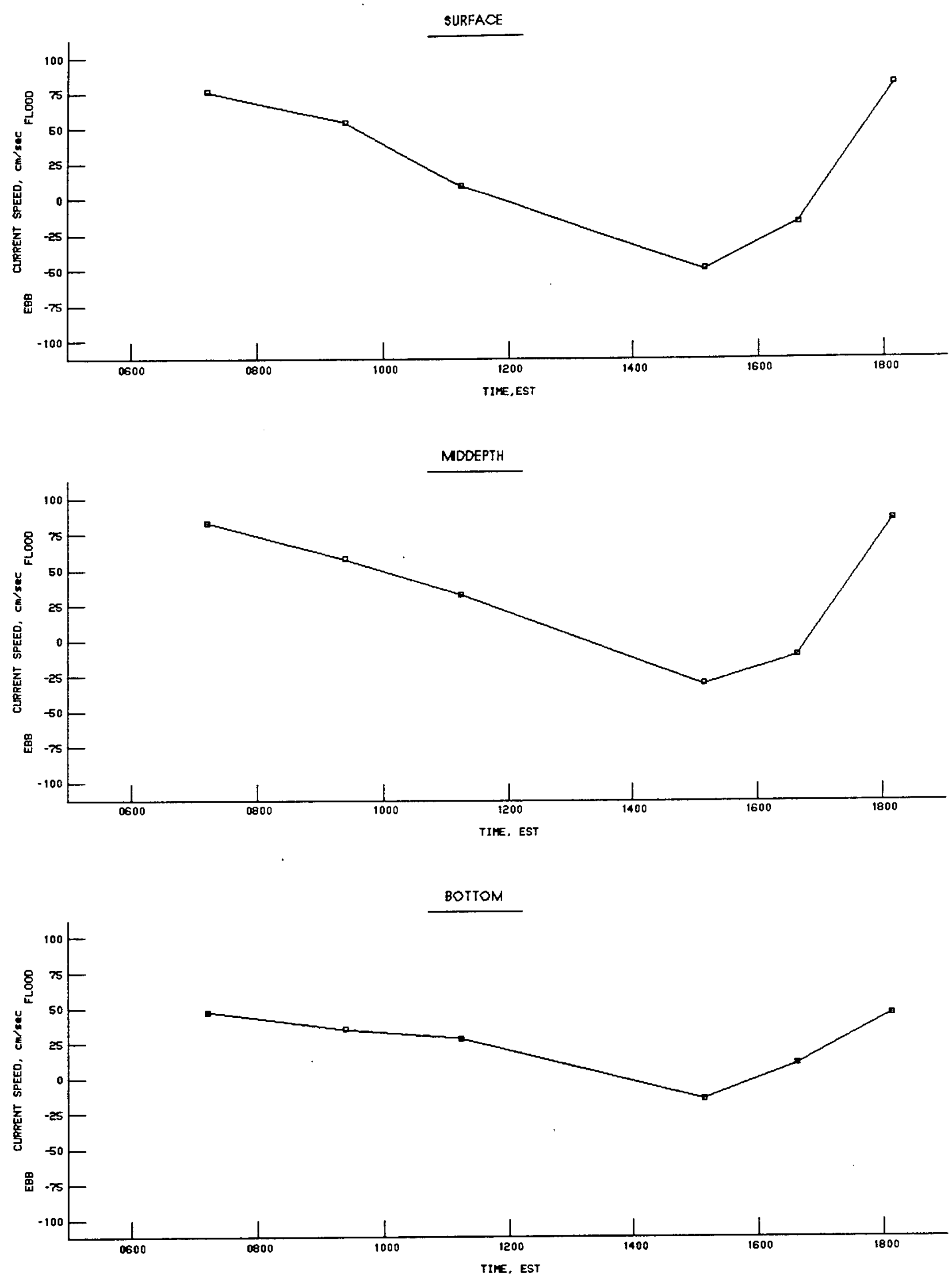


CURRENT SPEED
STATION RNB-1 (300)
SURFACE, MIDDEPTH, AND BOTTOM
08/19/93

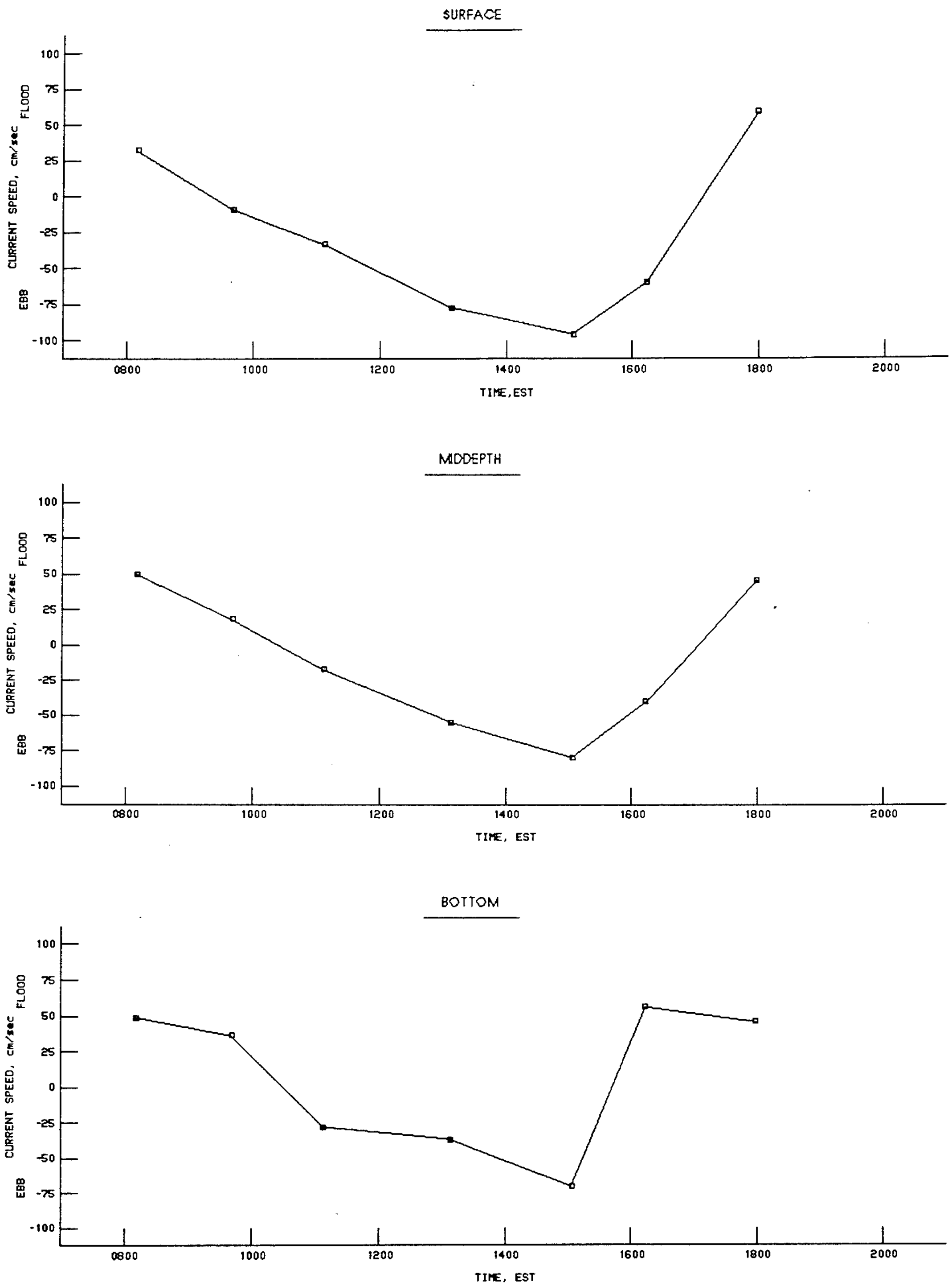


CURRENT SPEED
STATION RNB-1 (500)
SURFACE, MIDDEPTH, AND BOTTOM
08/19/93

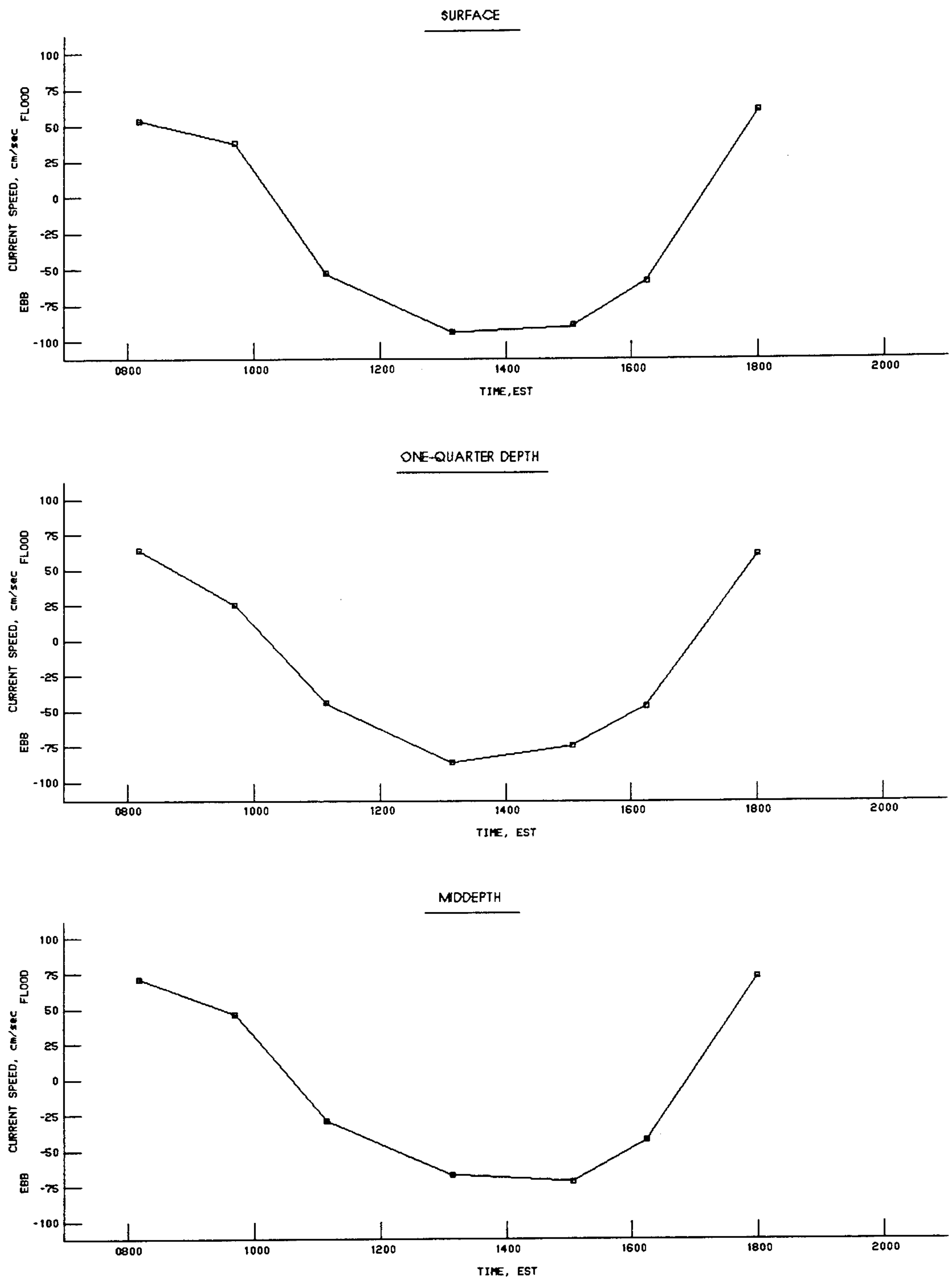
Plate 112



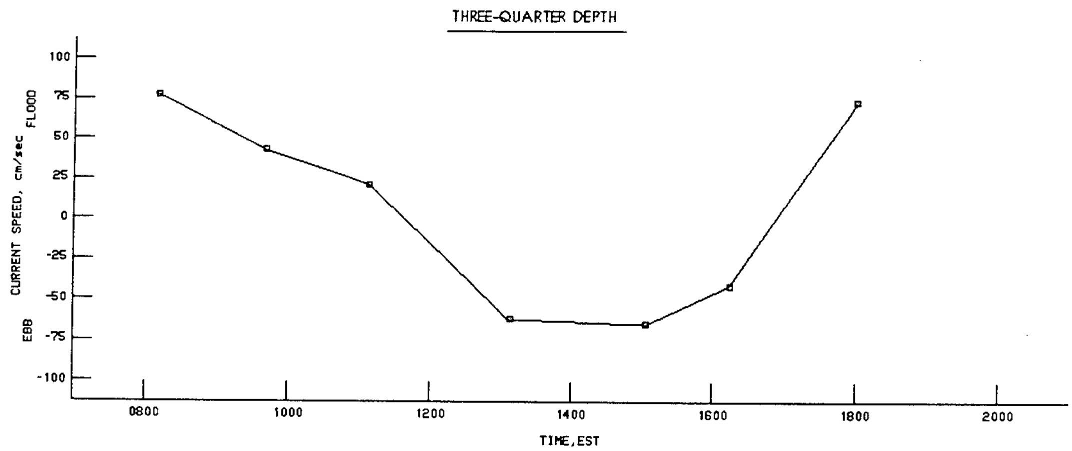
CURRENT SPEED
STATION RNB-1 (800)
SURFACE, MIDDEPTH, AND BOTTOM
08/19/93

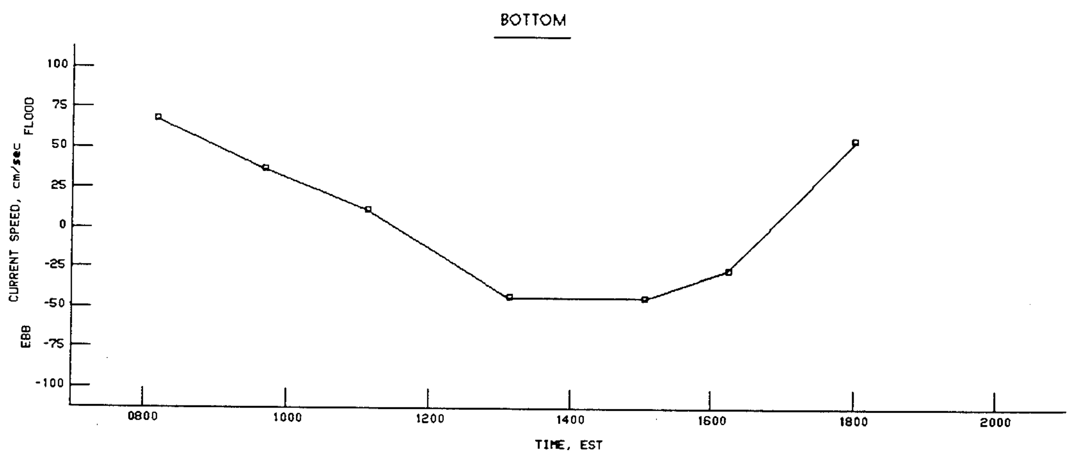


CURRENT SPEED
STATION RSB-1 (100)
SURFACE, MIDDEPTH, AND BOTTOM
08/19/93

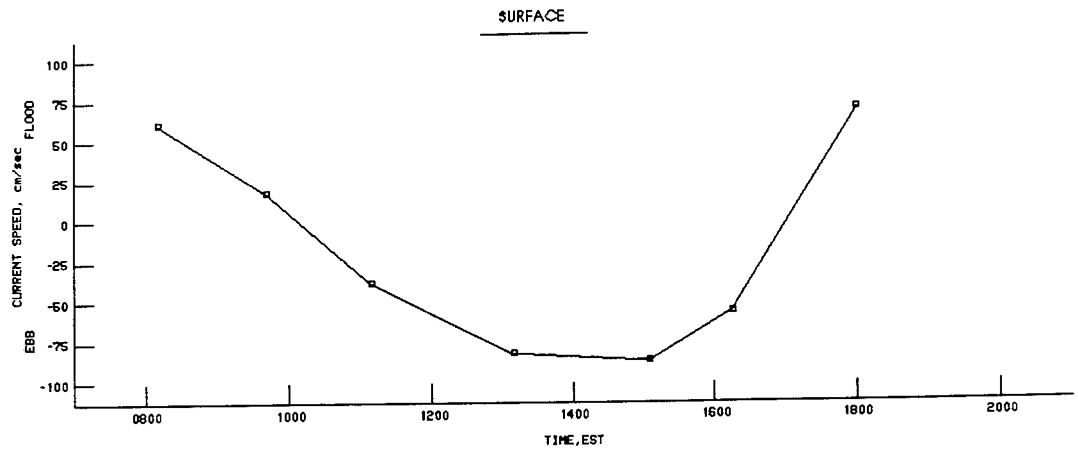


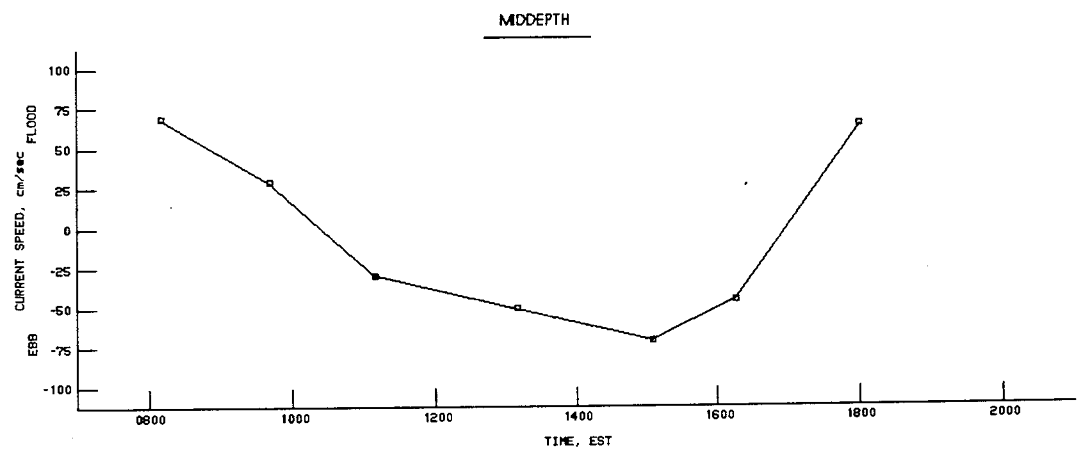
CURRENT SPEED
STATION RSB-1 (300)
SURFACE, ONE-QUARTER DEPTH, AND MIDDEPTH
08/19/93

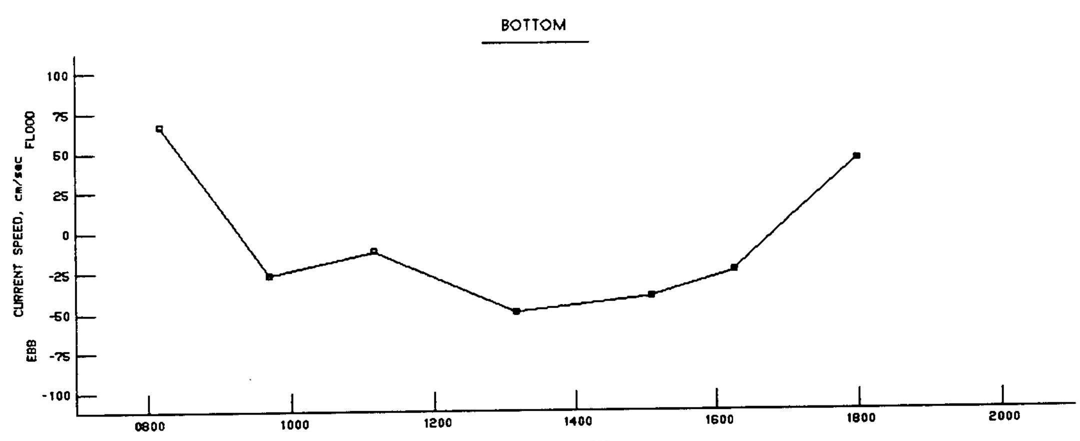




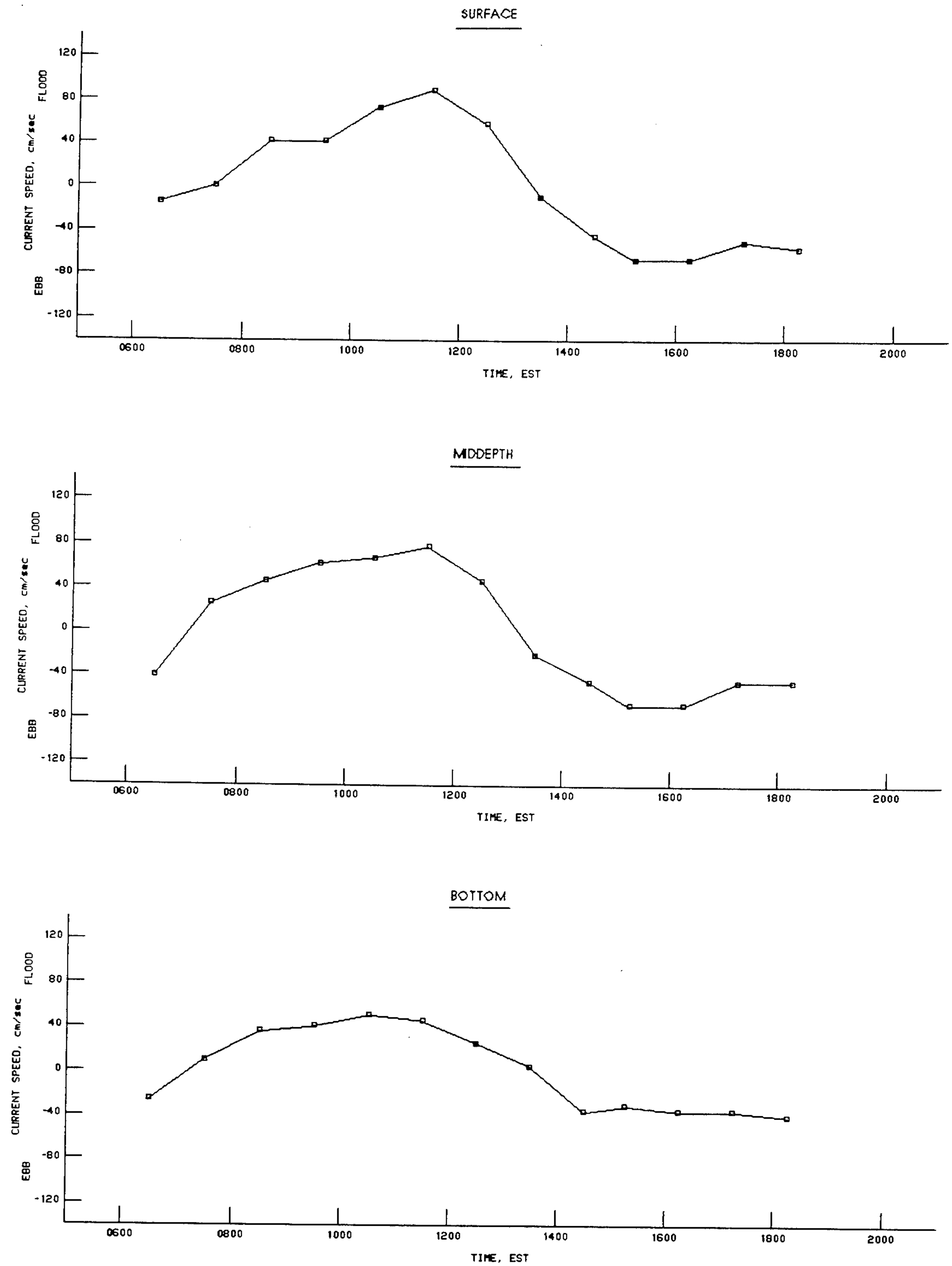
CURRENT SPEED
STATION RSB-1 (300)
THREE-QUARTER DEPTH AND BOTTOM
08/19/93



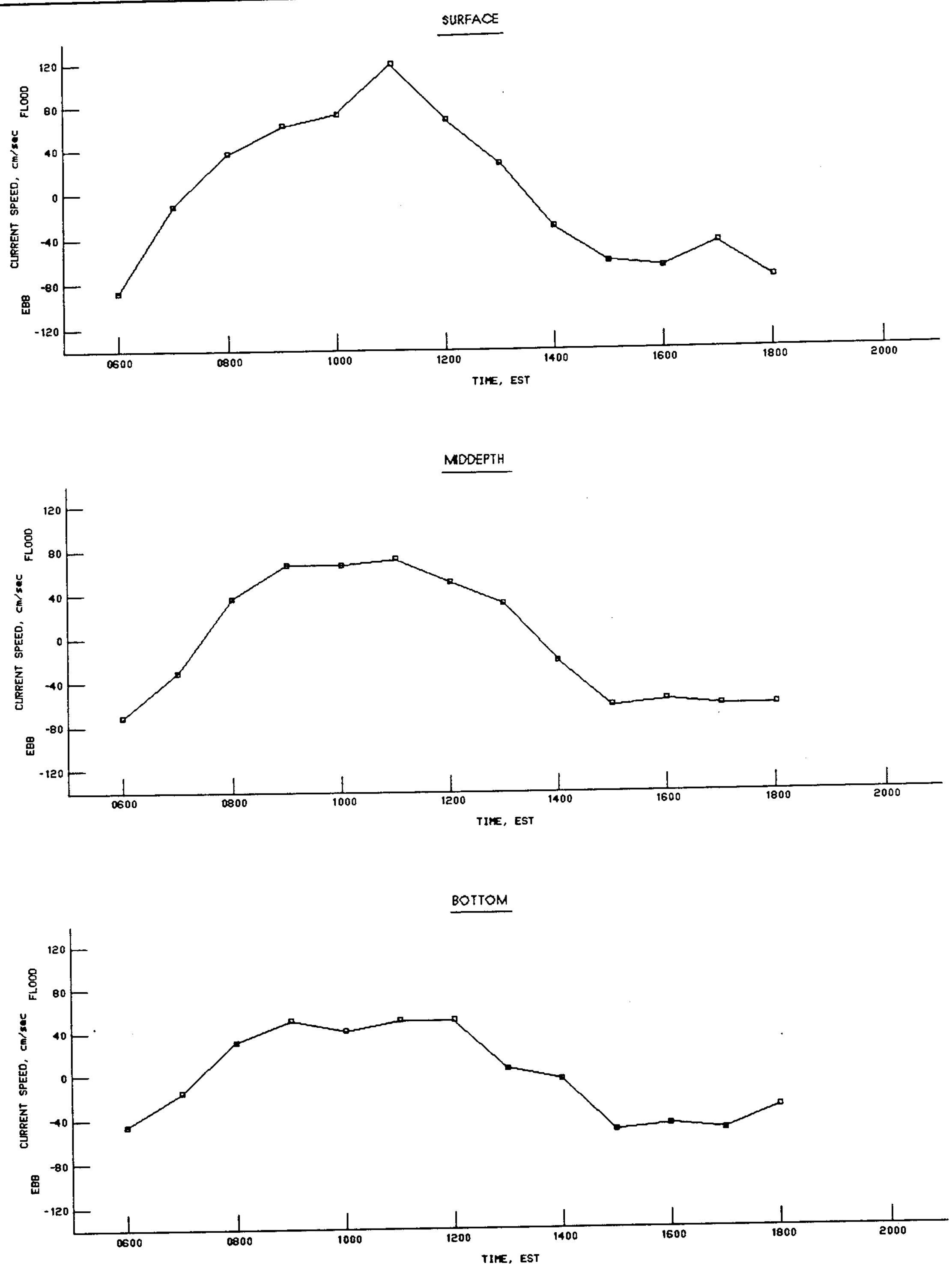




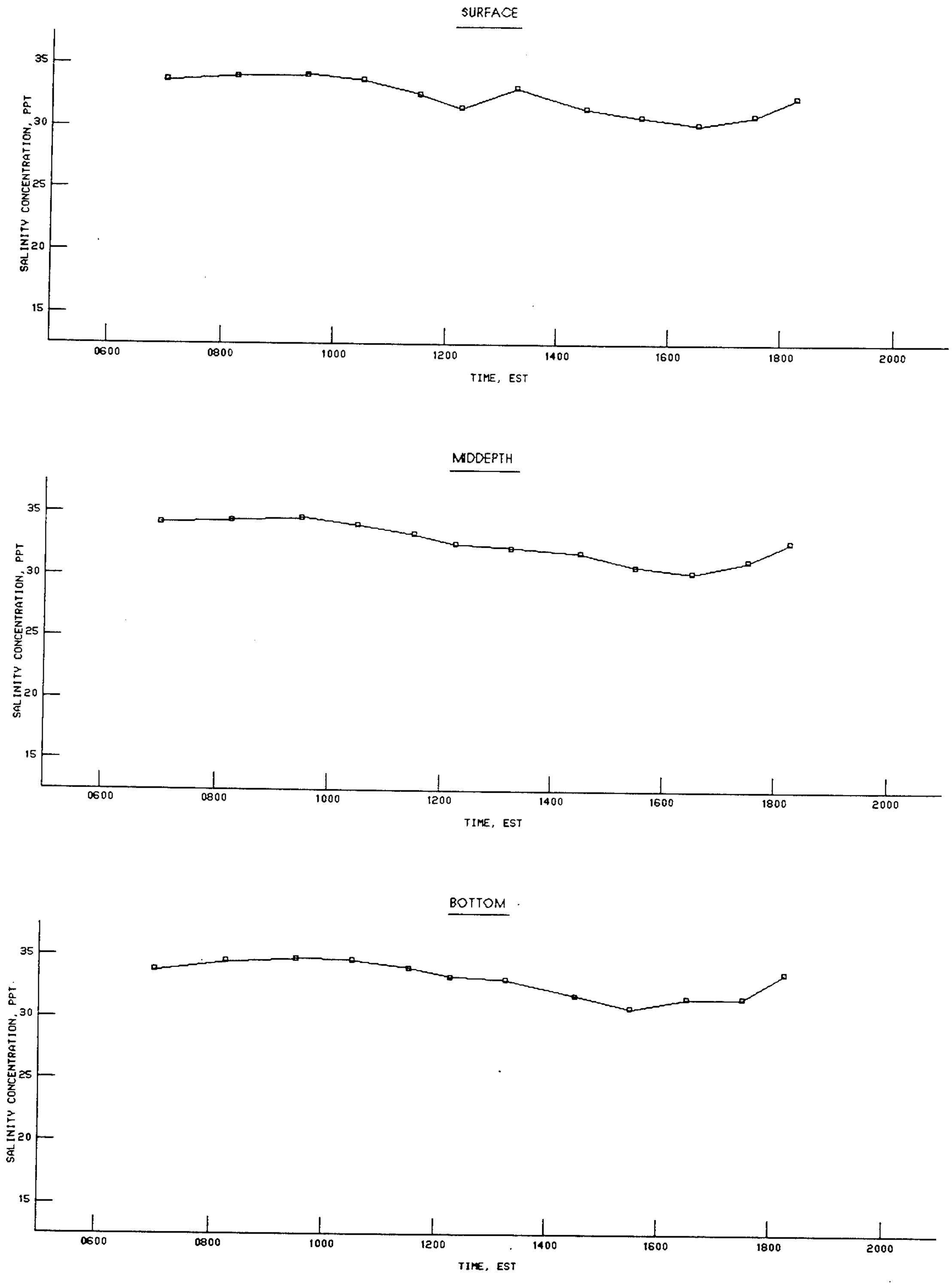
CURRENT SPEED
STATION RSB-1 (500)
SURFACE, MIDDEPTH, AND BOTTOM
08/19/93



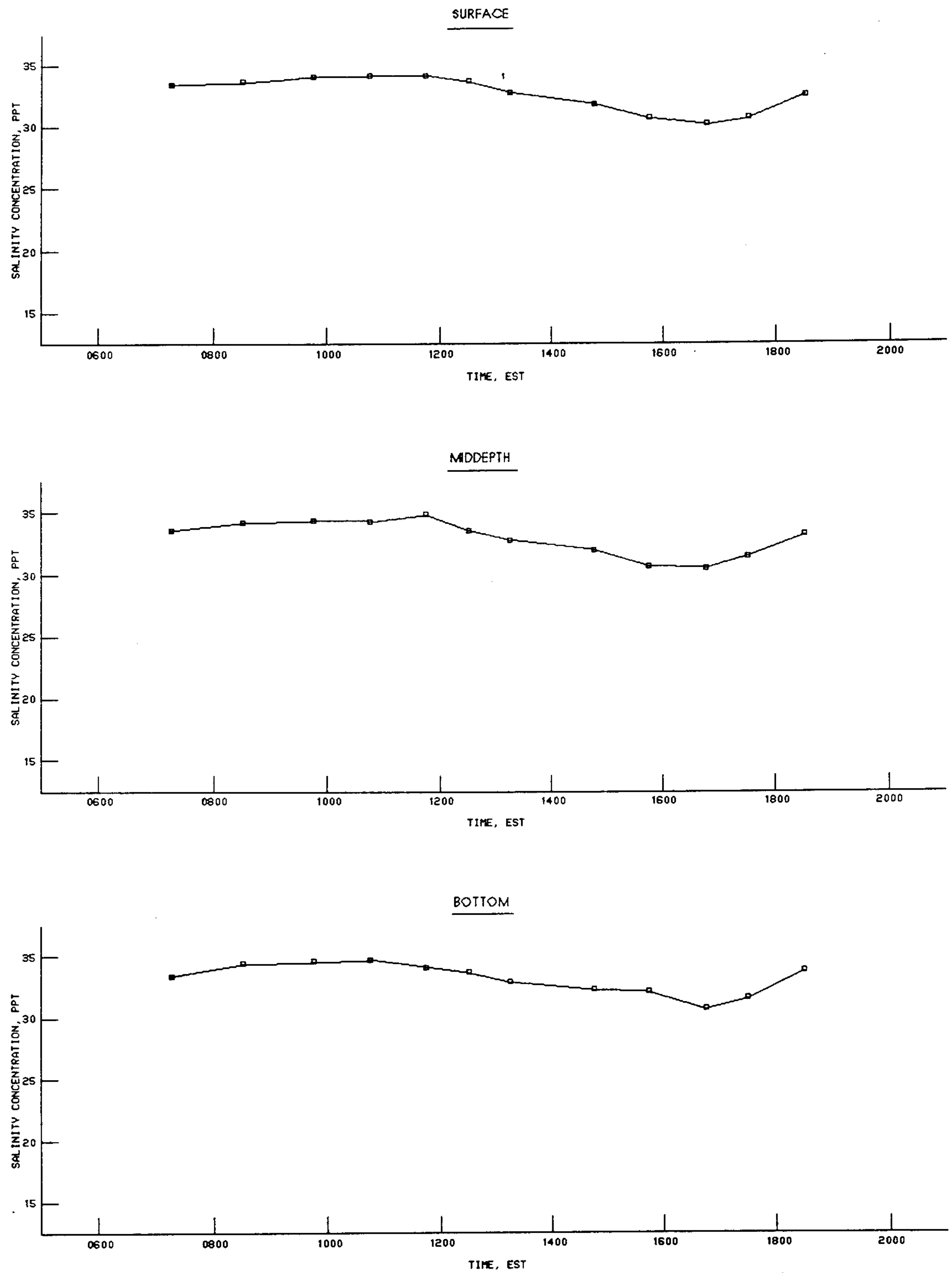
CURRENT SPEED
RANGE 9.0
08/20/93



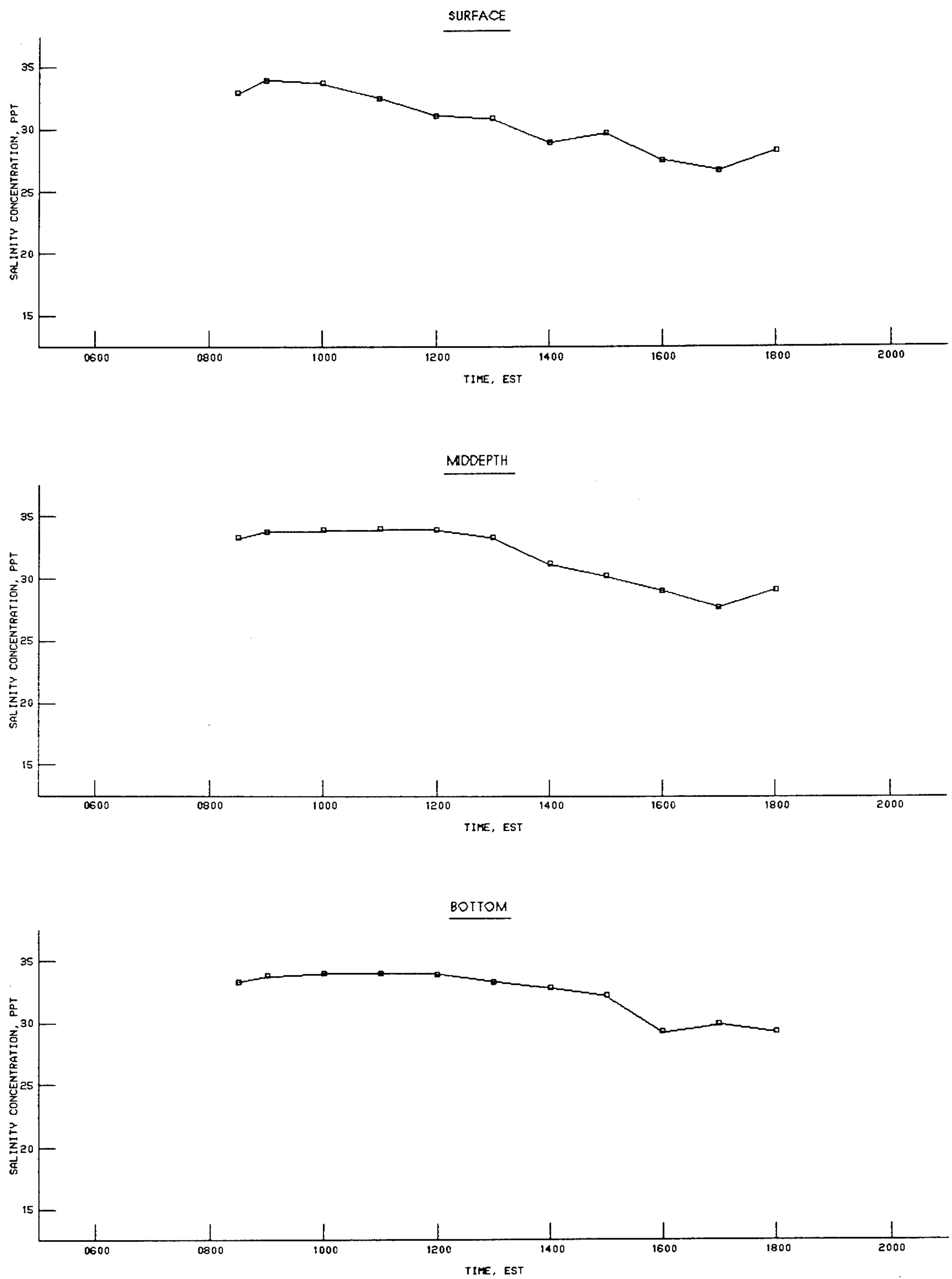
CURRENT SPEED
RANGE 10.0
08/20/93



SALINITY CONCENTRATION
STATION 1.0A
08/19/93

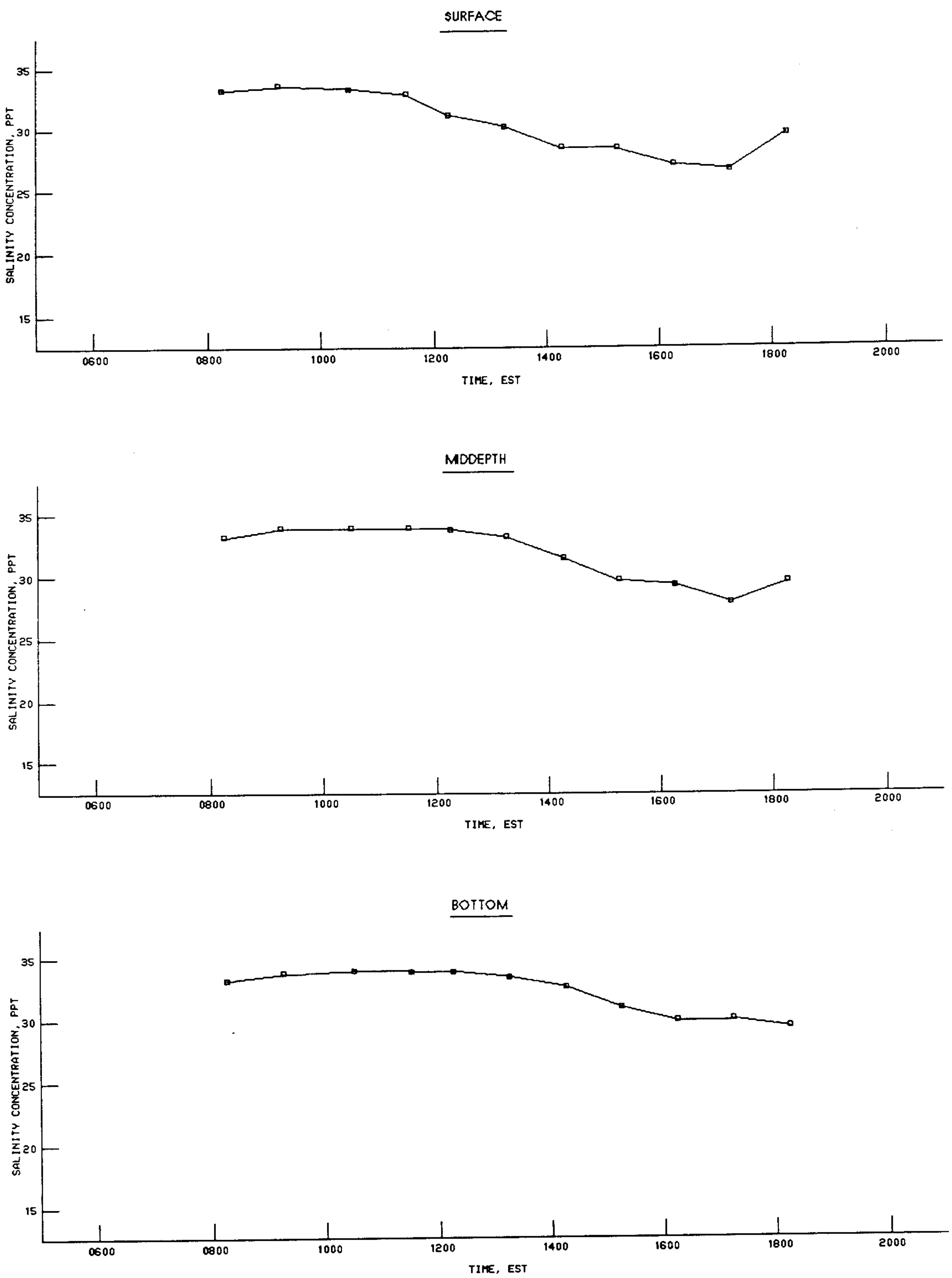


SALINITY CONCENTRATION
STATION 1.0C
08/19/93



SALINITY CONCENTRATION
STATION 2.0A
08/19/93

Plate 122



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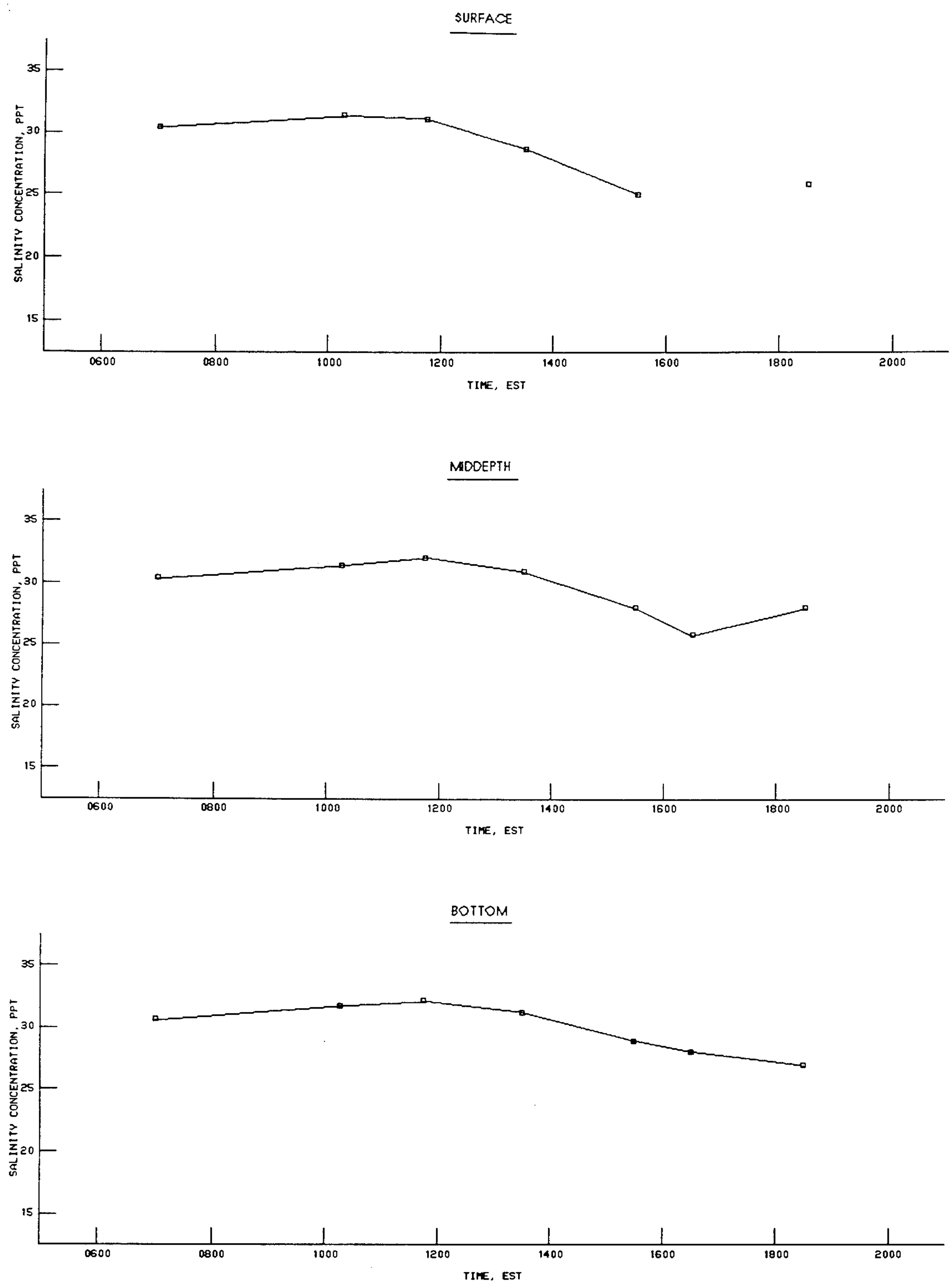
STATION 2.0C
08/19/93



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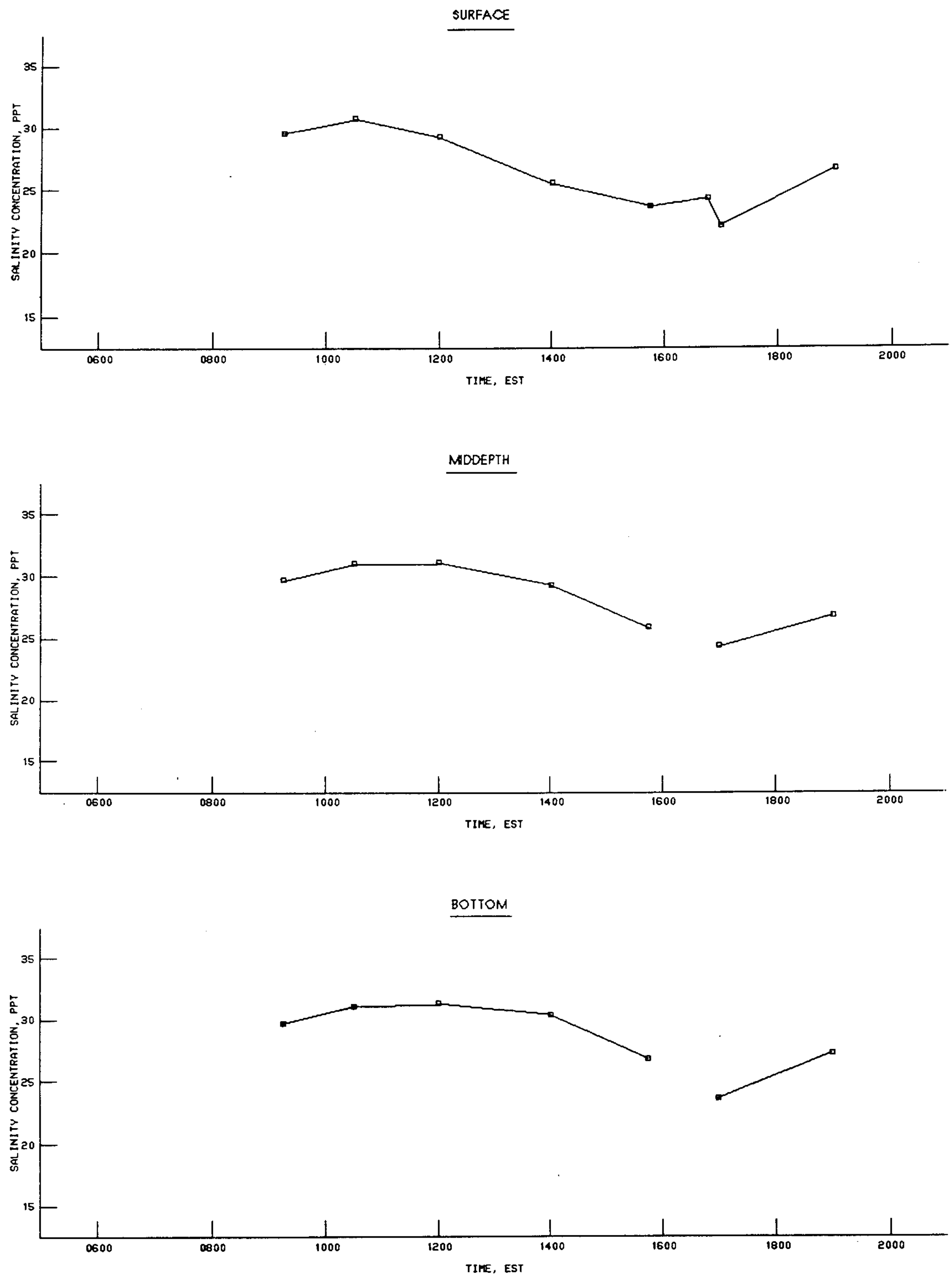
STATION 3.1B
08/19/93



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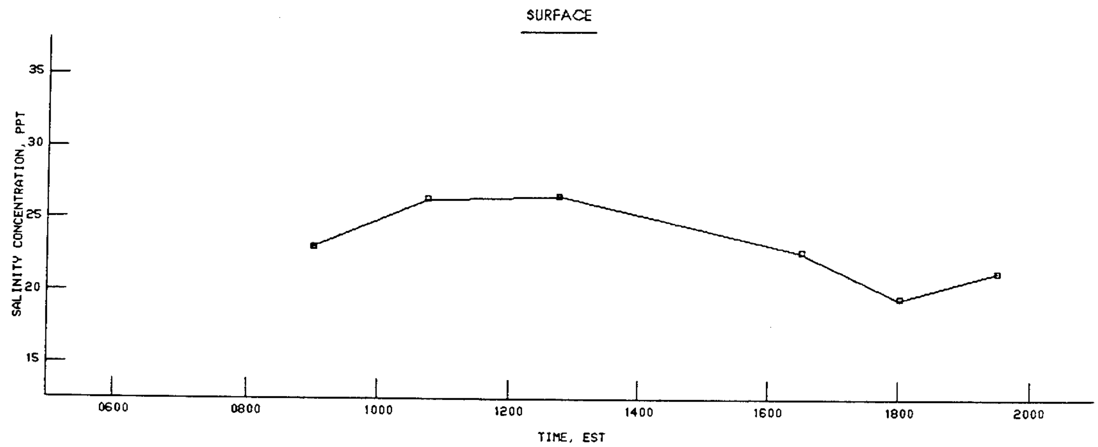

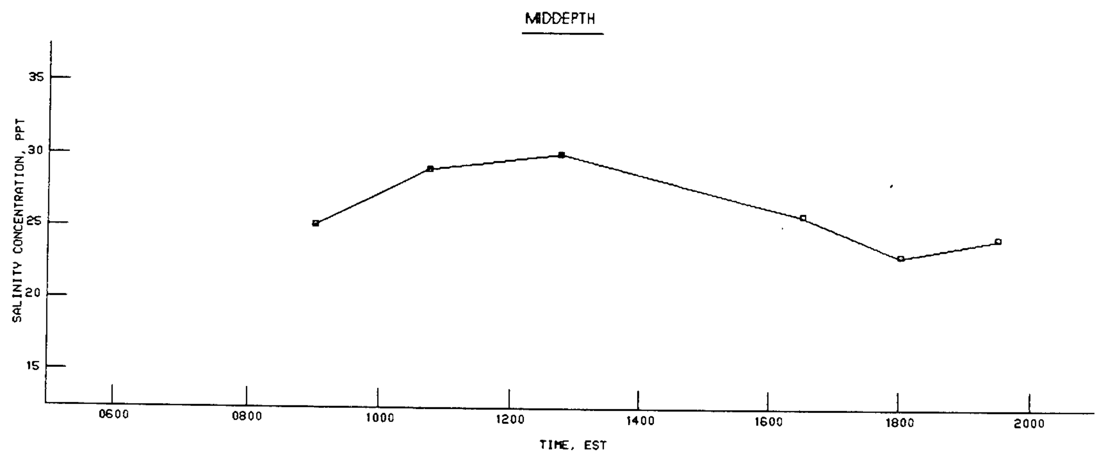

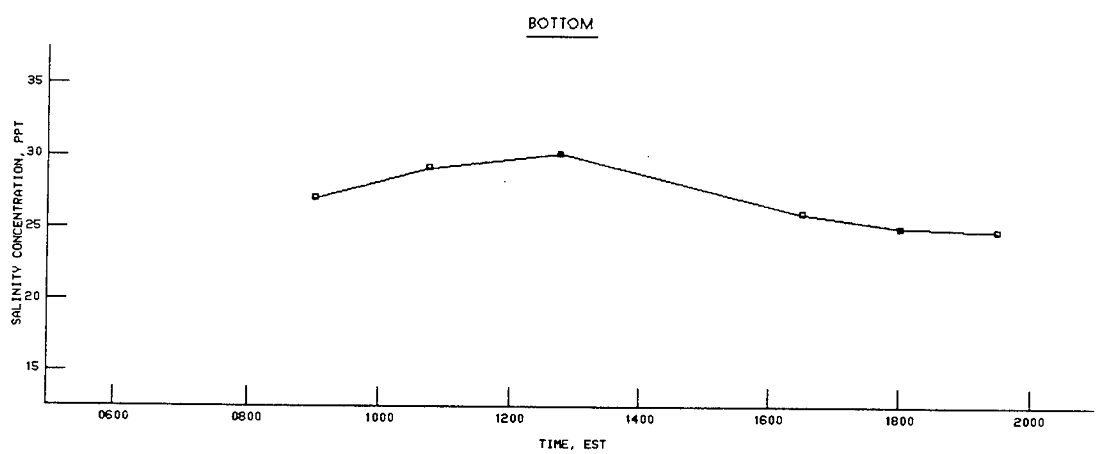

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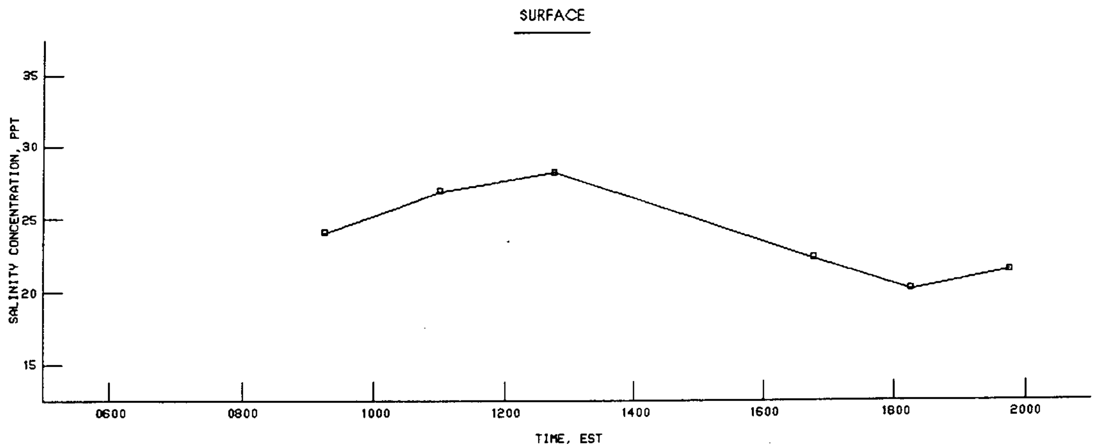

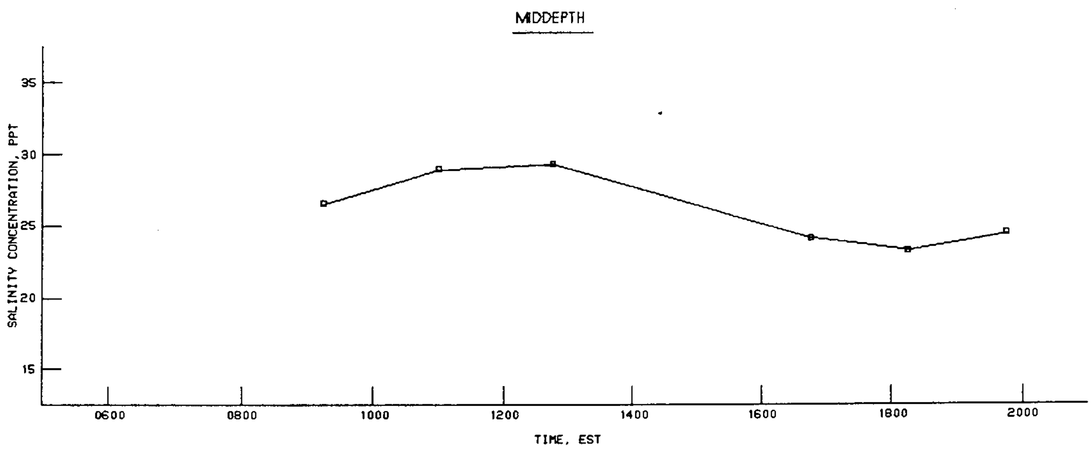

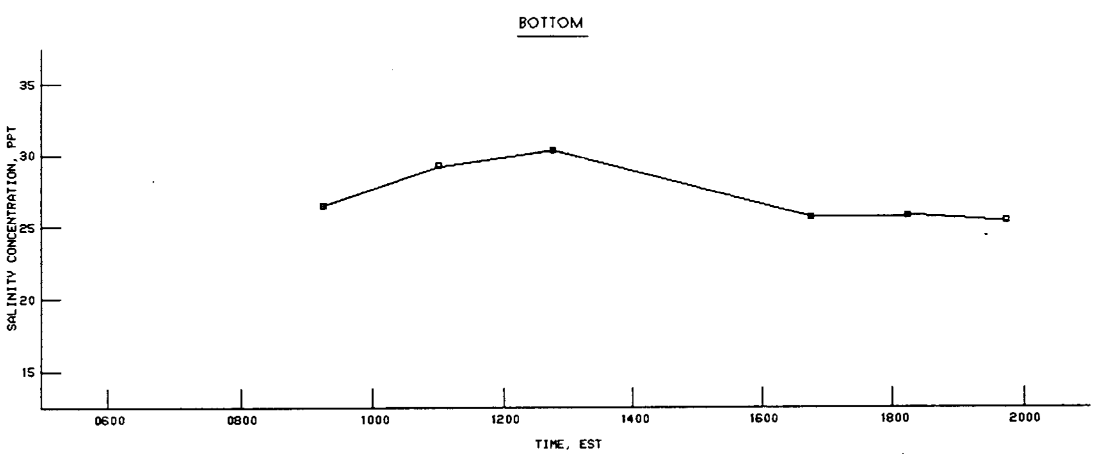

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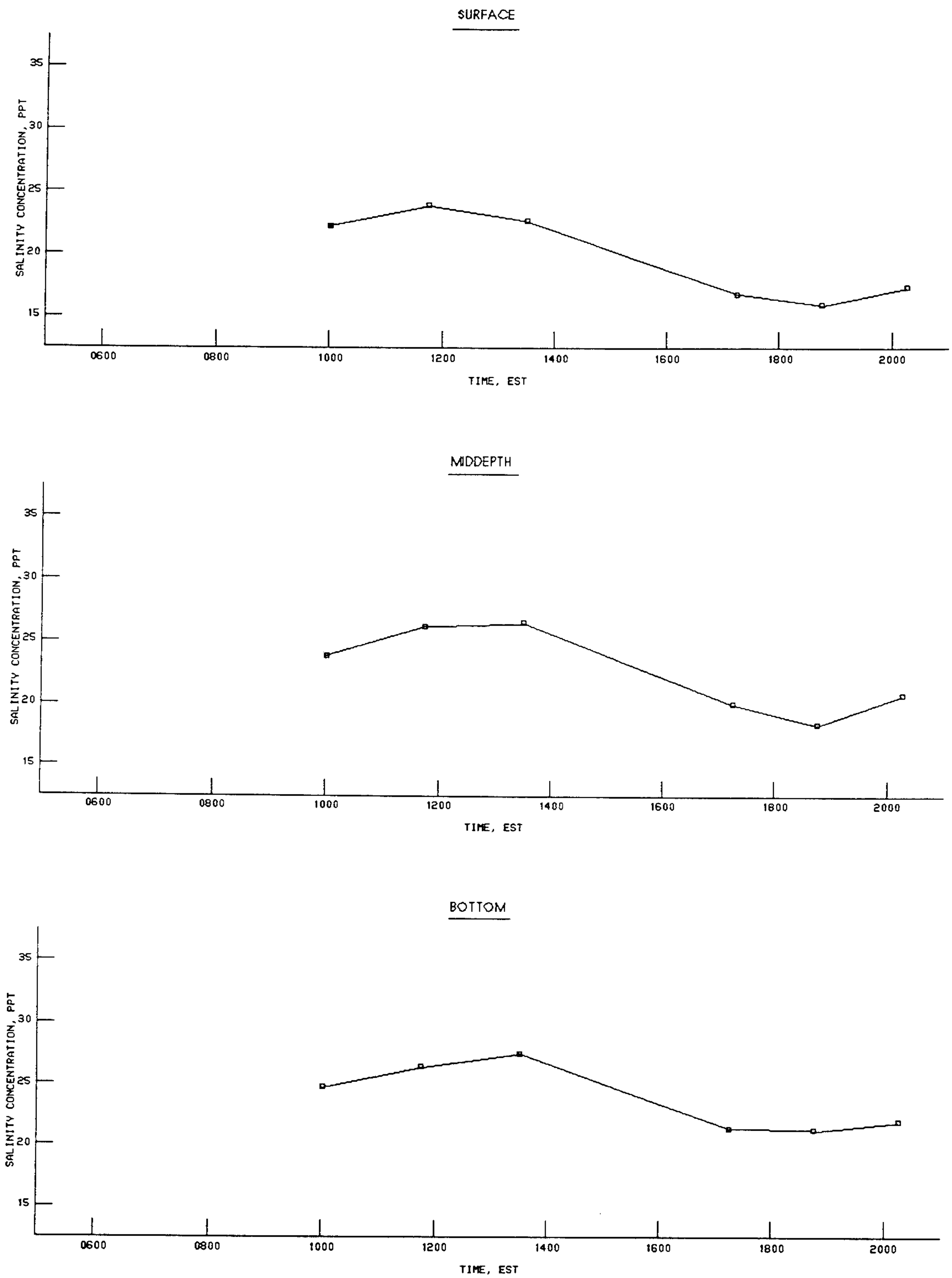

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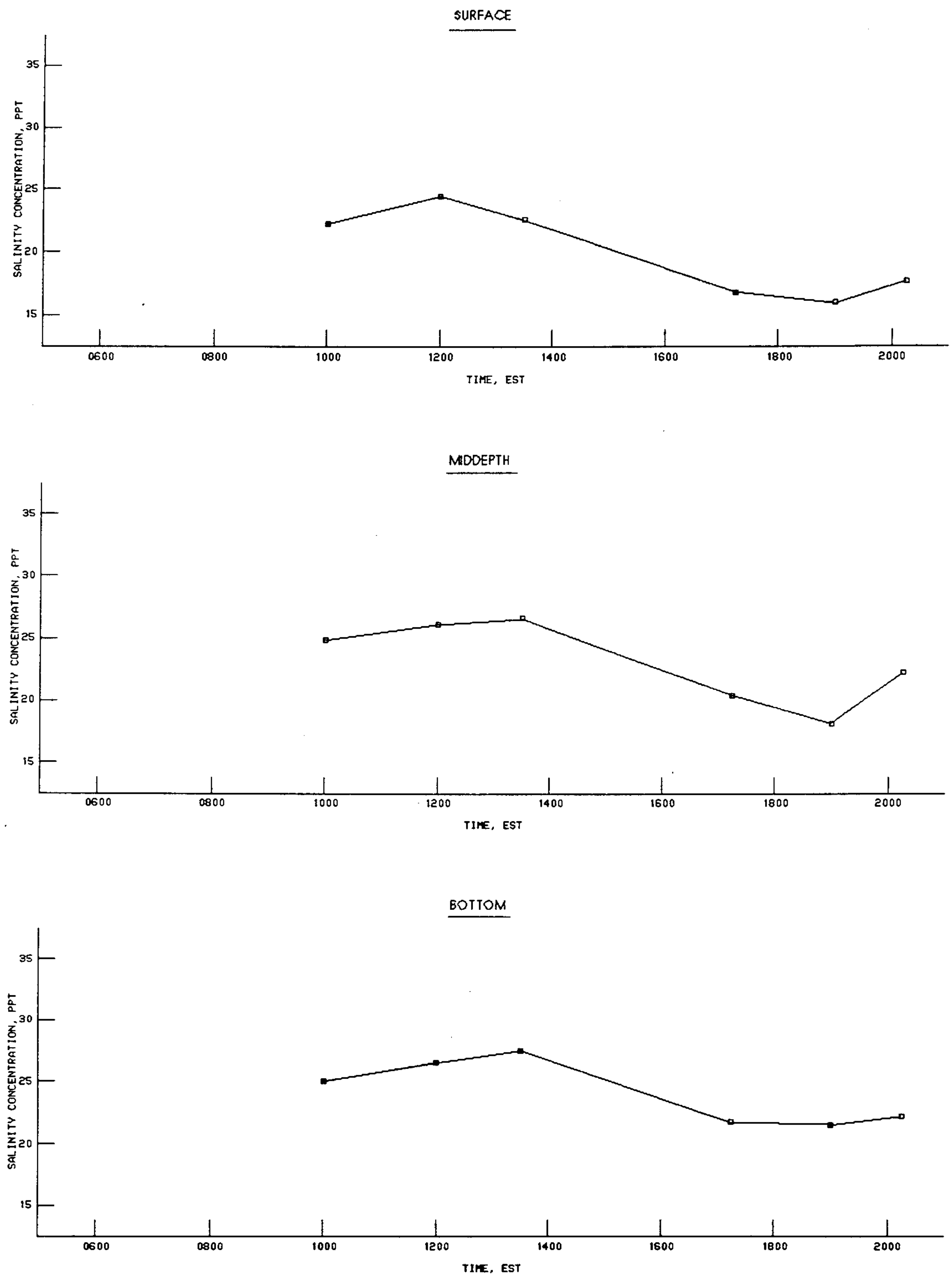
08/19/93



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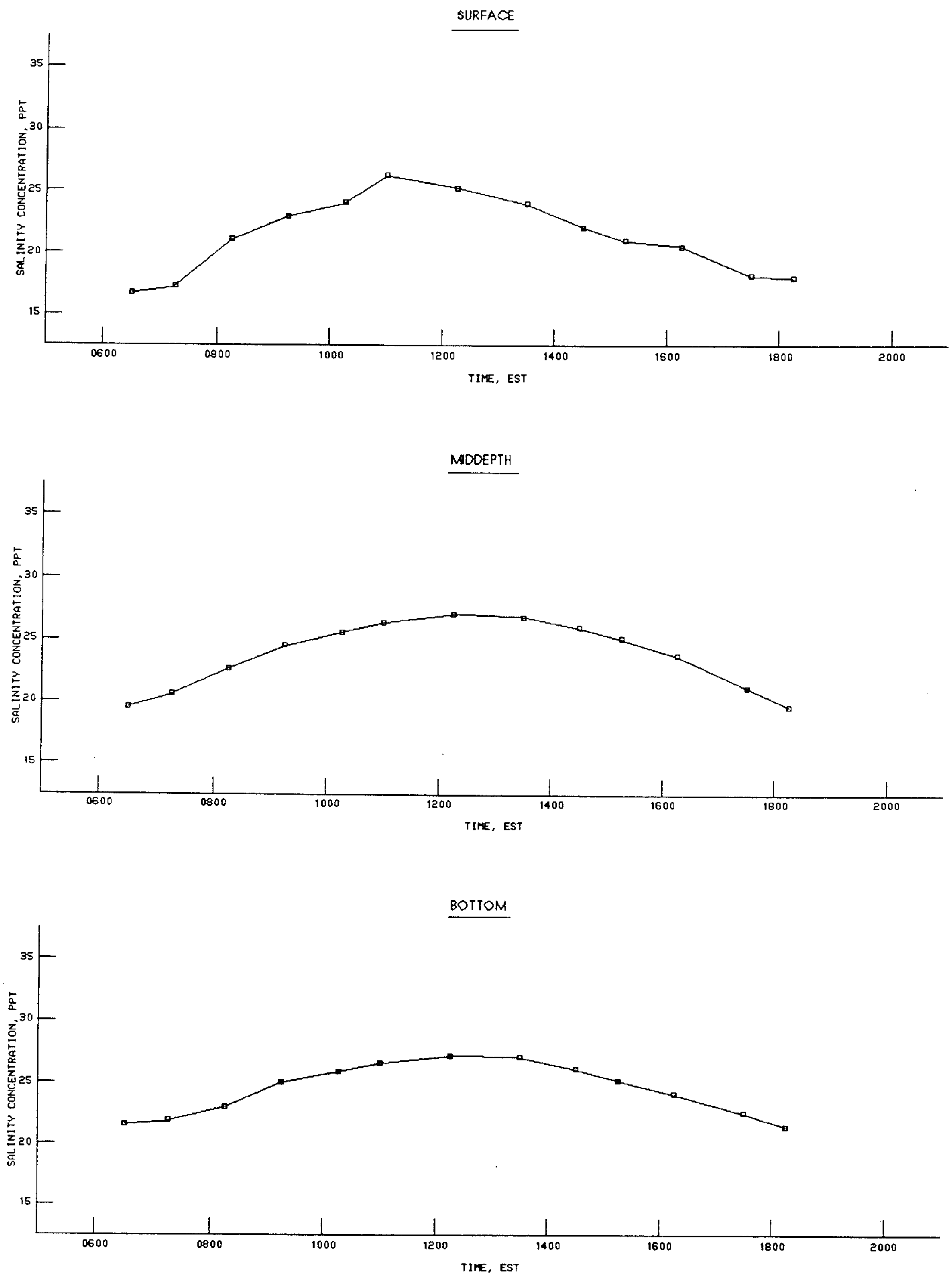

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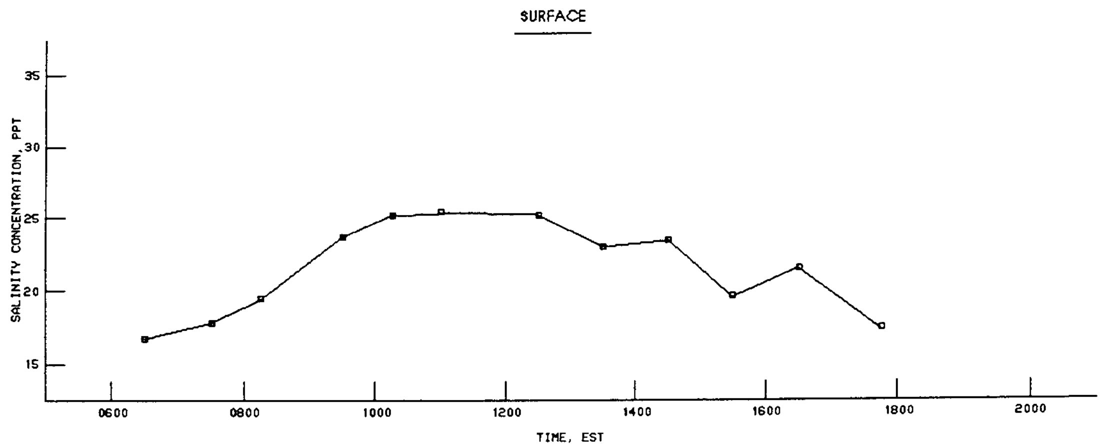
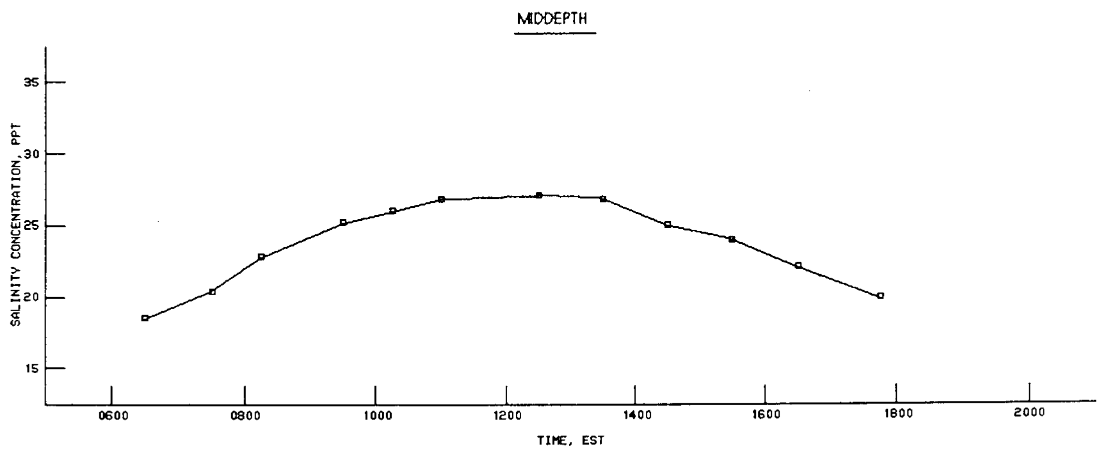
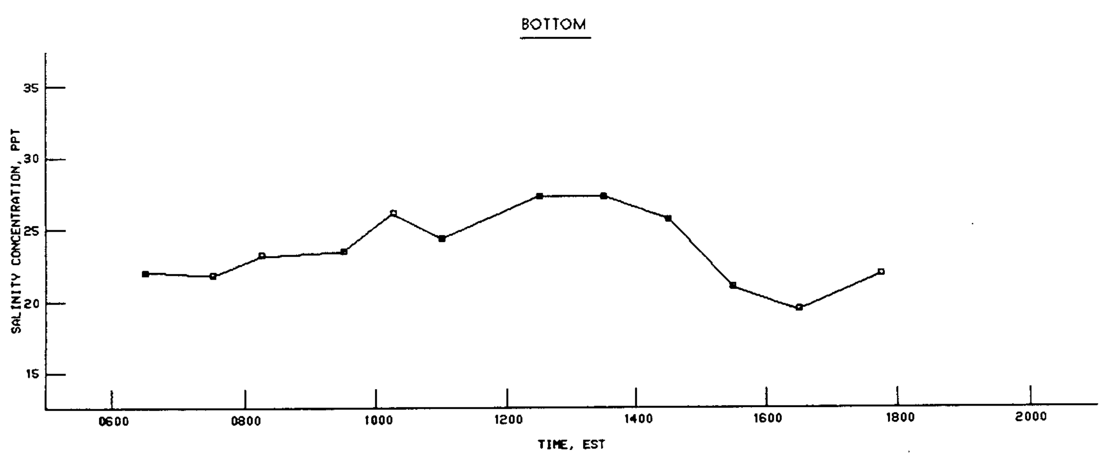
08/20/93







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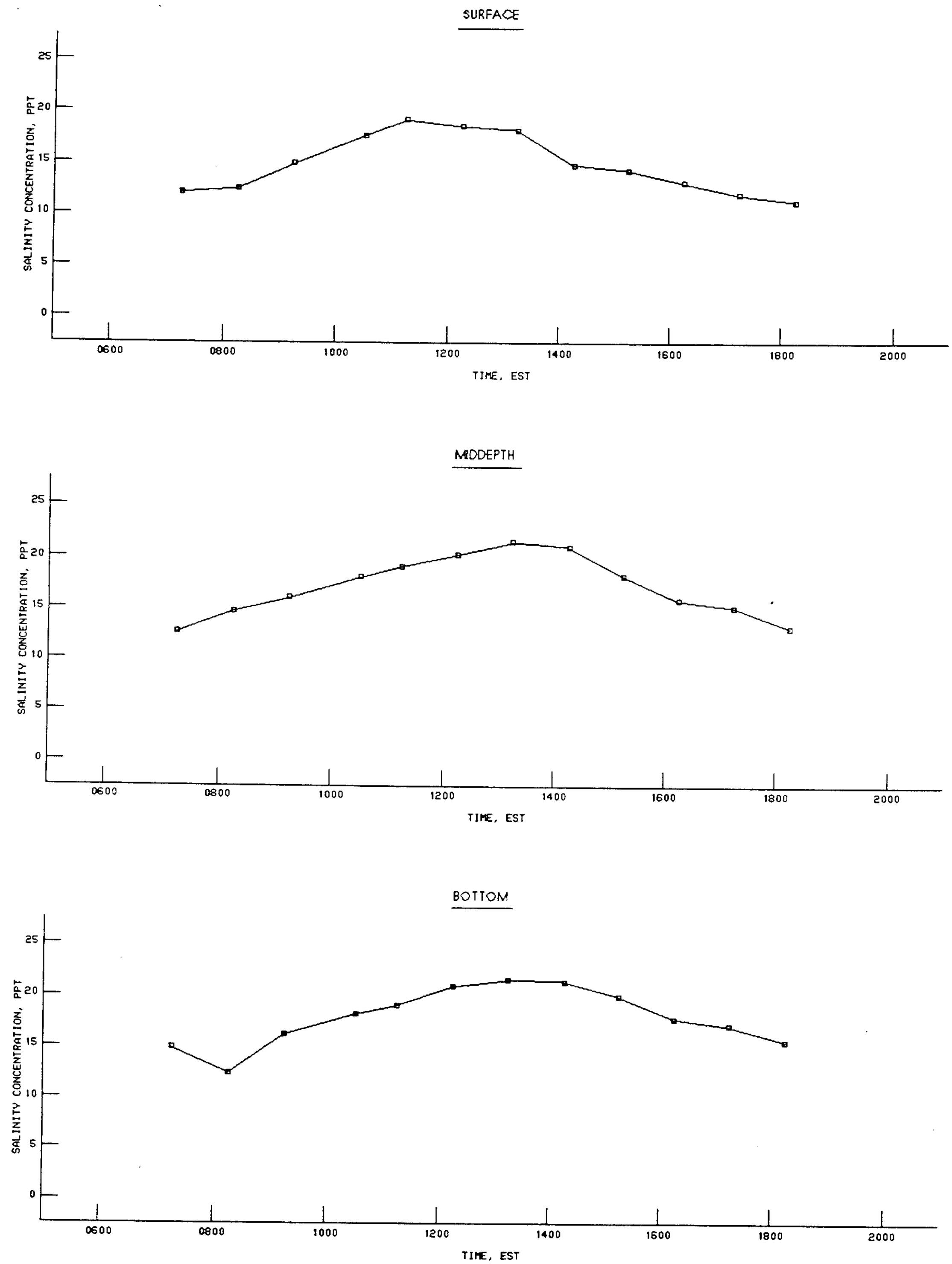

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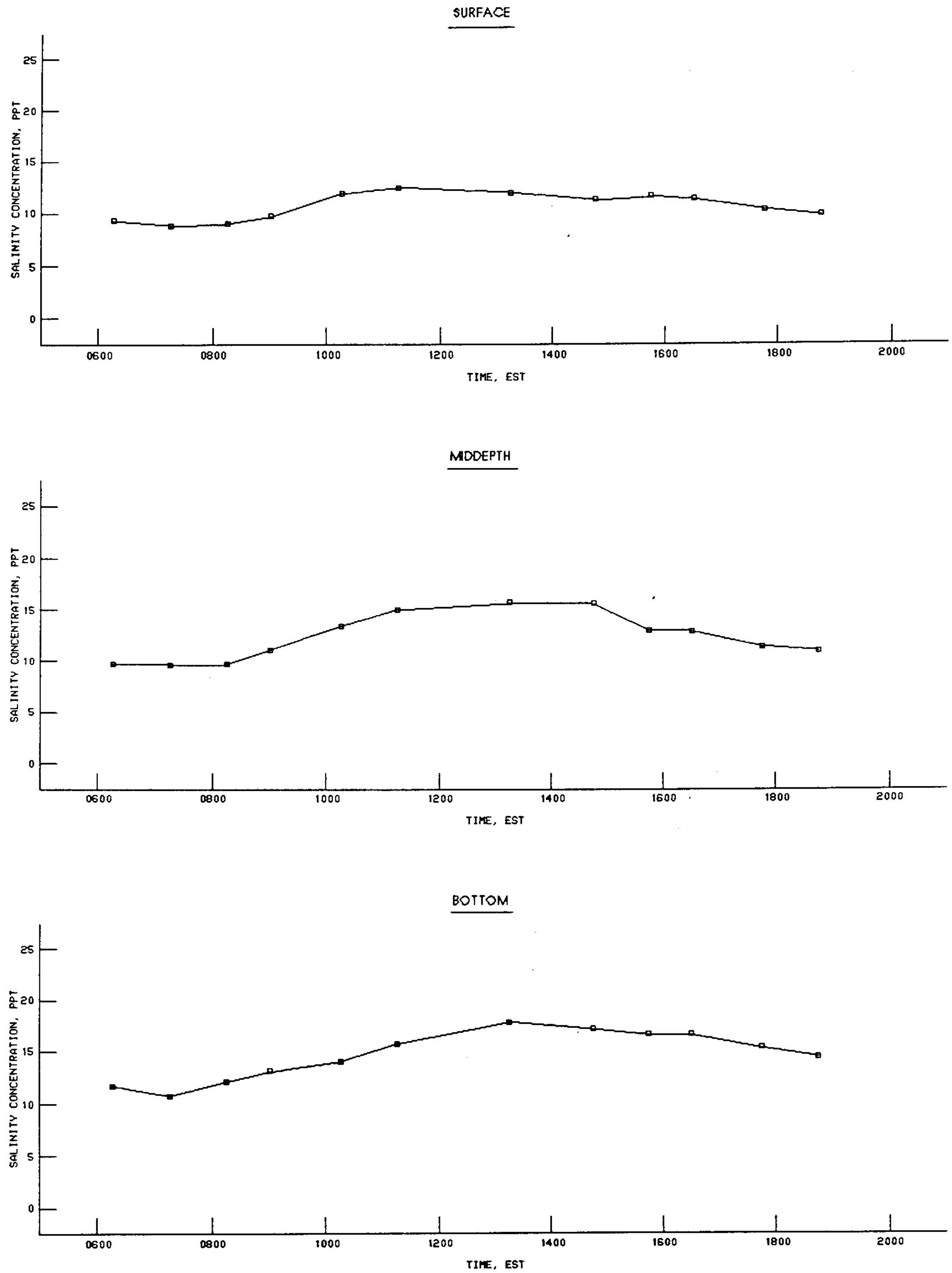
STATION 7.0B
08/20/93



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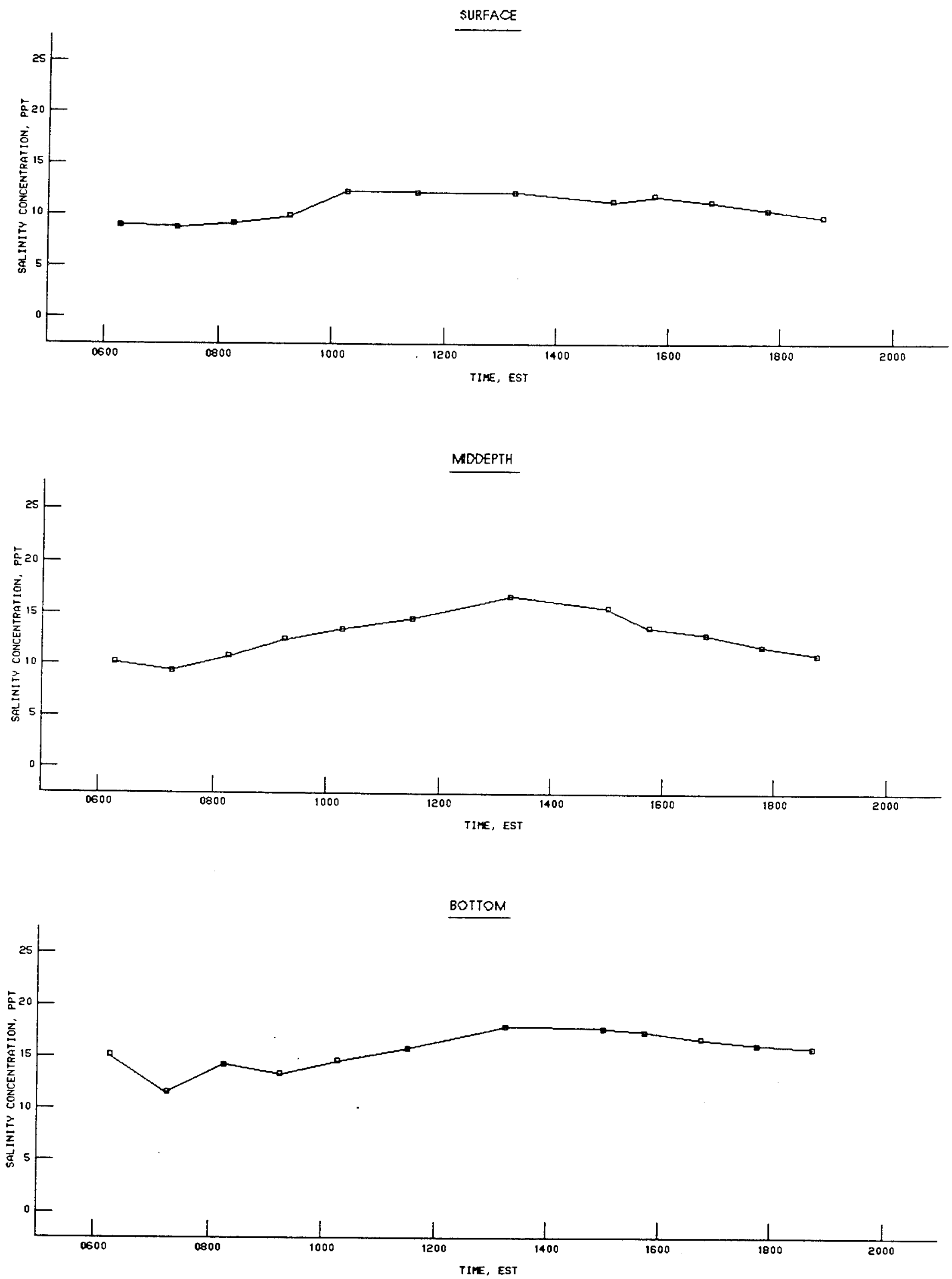
08/20/93



SALINITY CONCENTRATION
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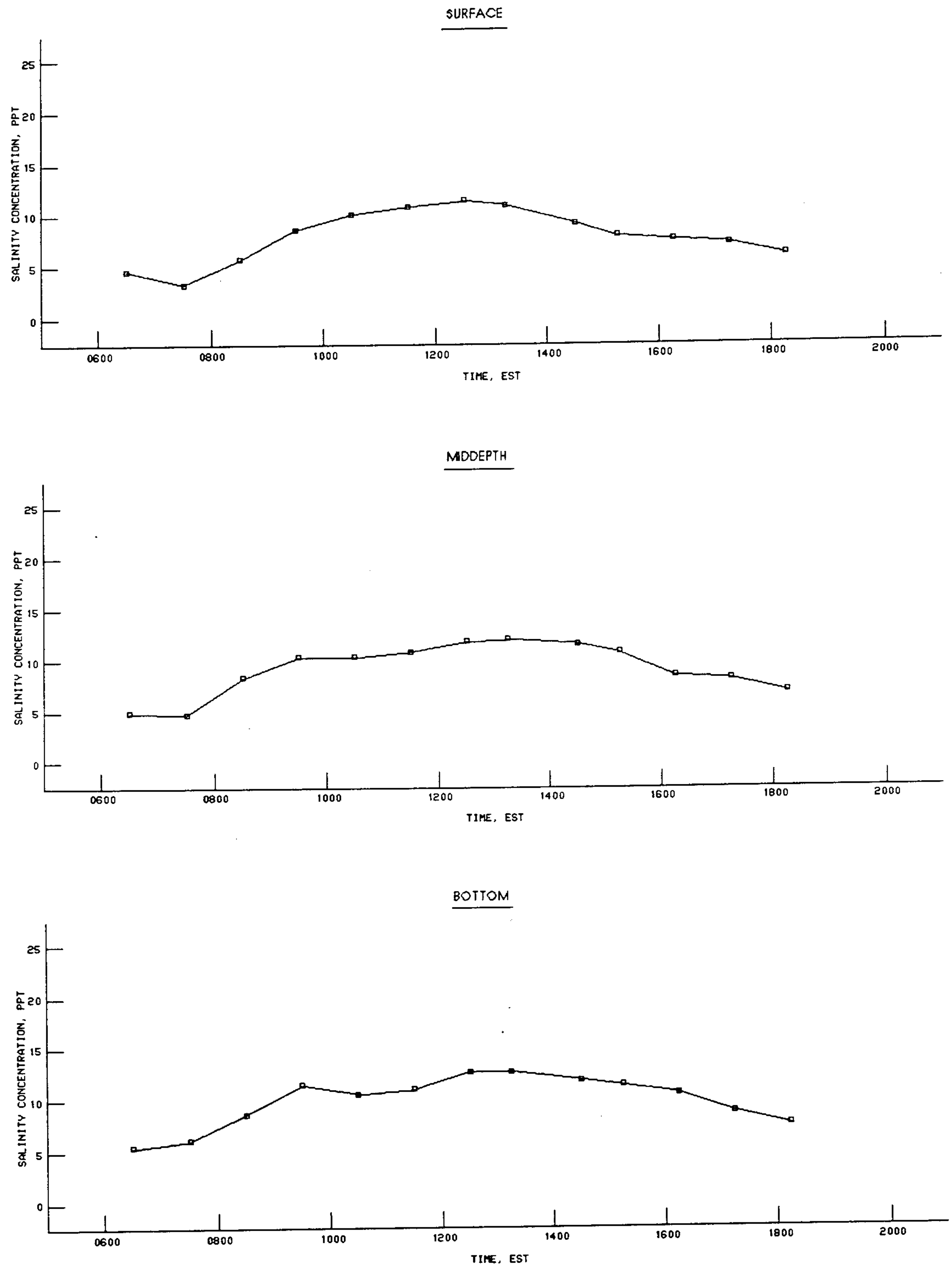
08/20/93



SALINITY CONCENTRATION
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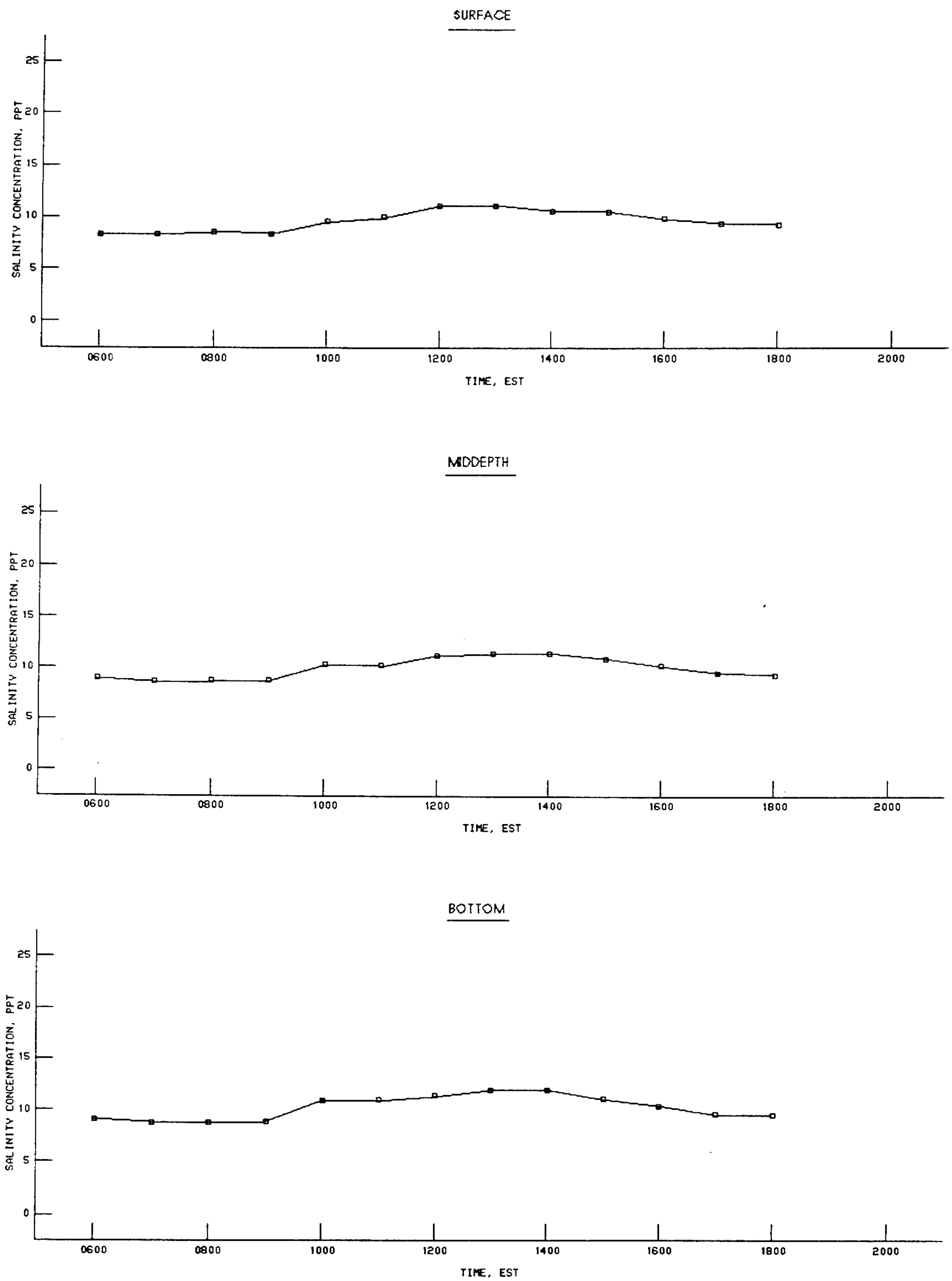
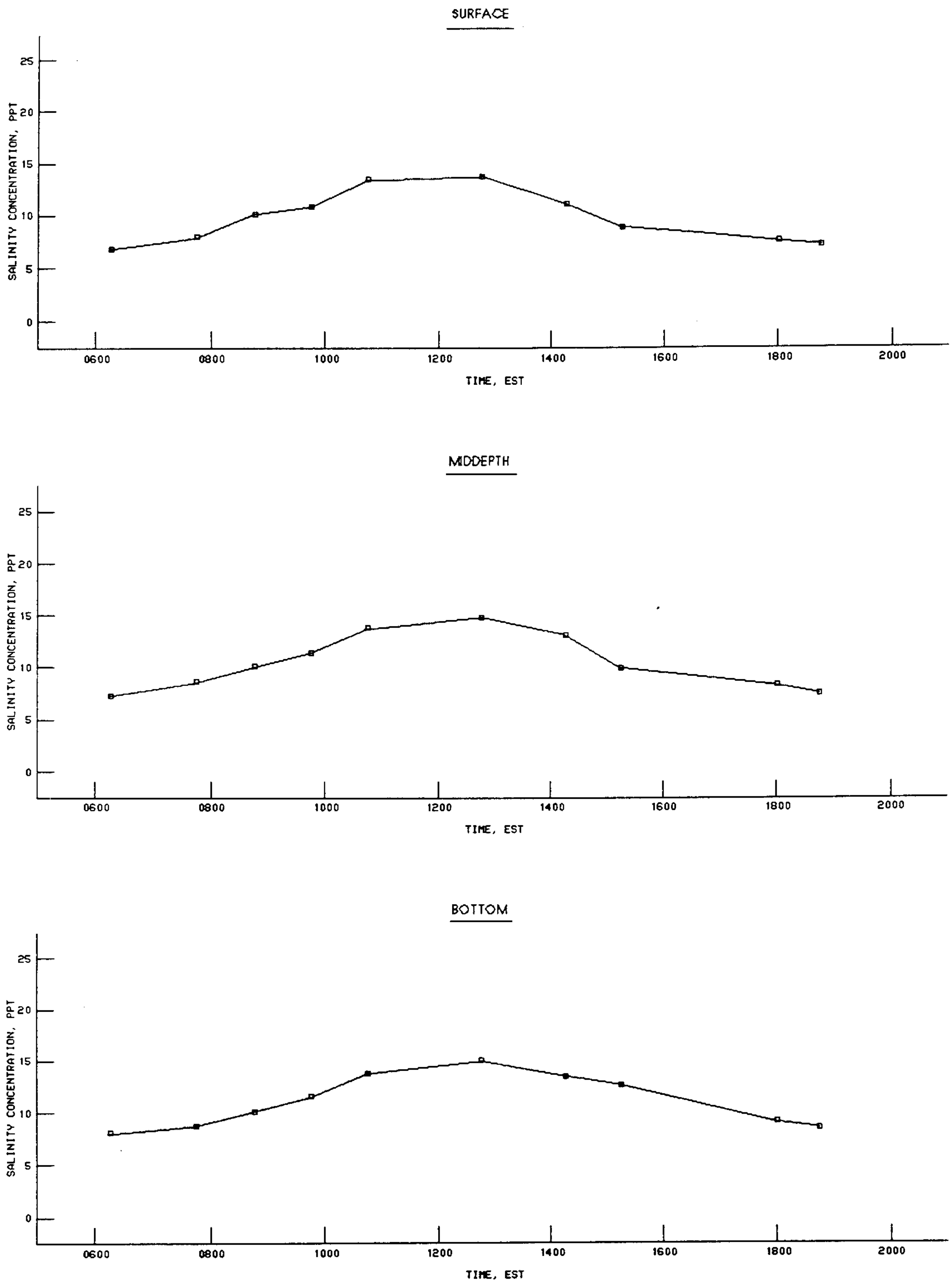
08/20/93

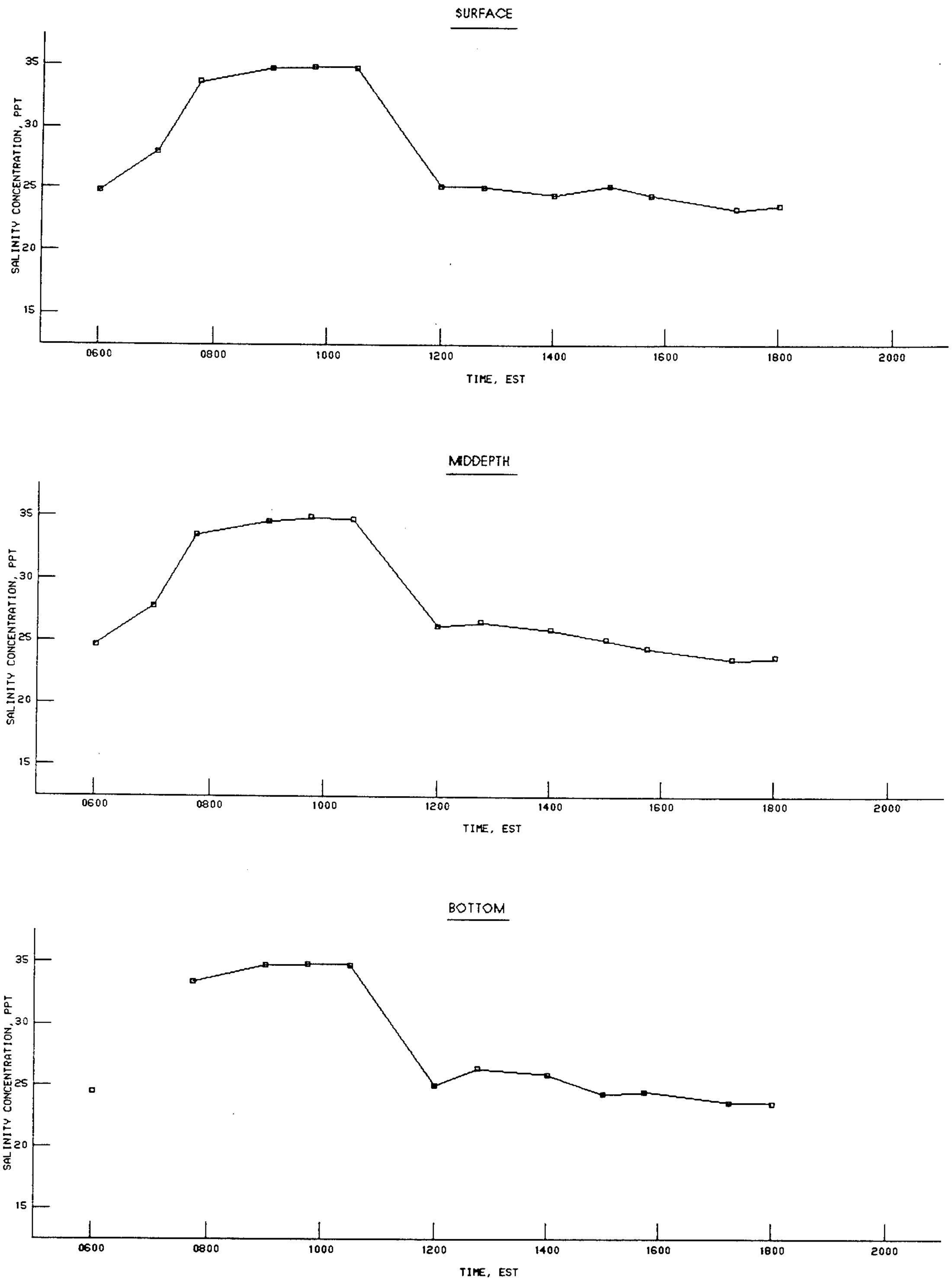


SALINITY CONCENTRATION
STATION 10.0B
08/20/93

Plate 136

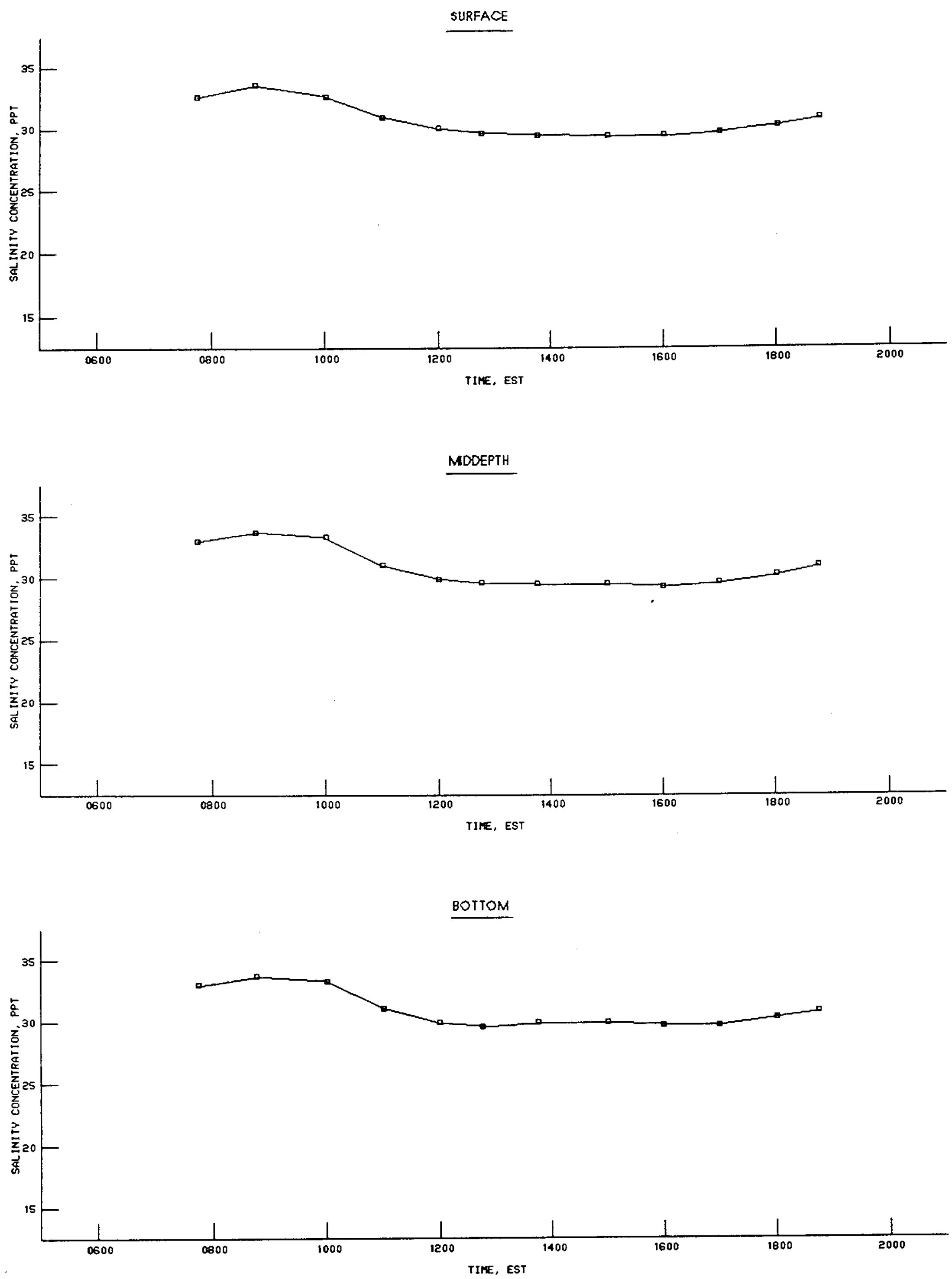


SALINITY CONCENTRATION
STATION 11.0B
08/20/93



SALINITY CONCENTRATION
STATION 12.0B
08/20/93

Plate 138



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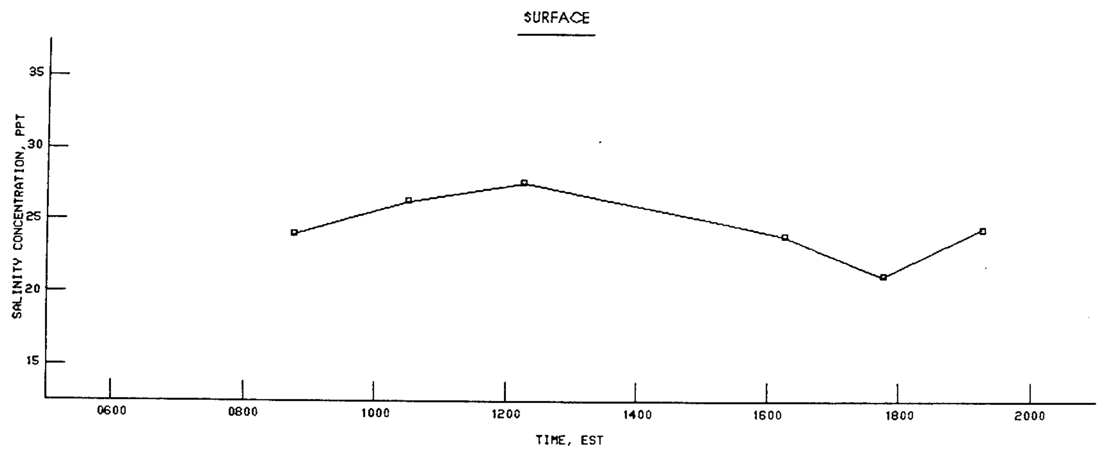
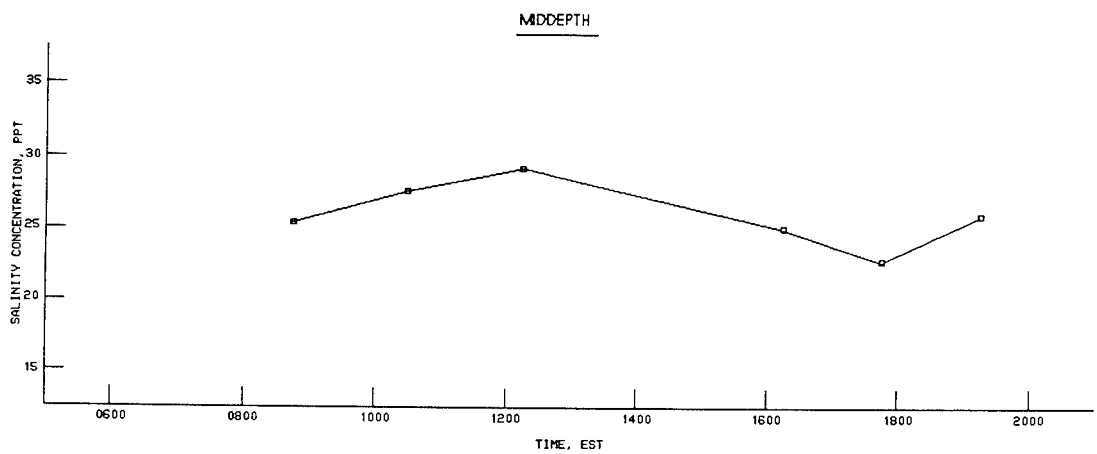
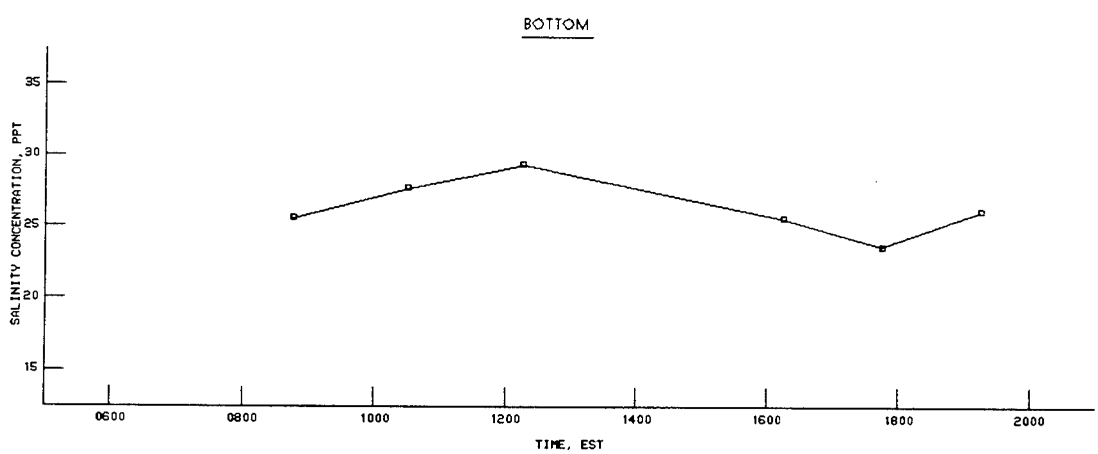
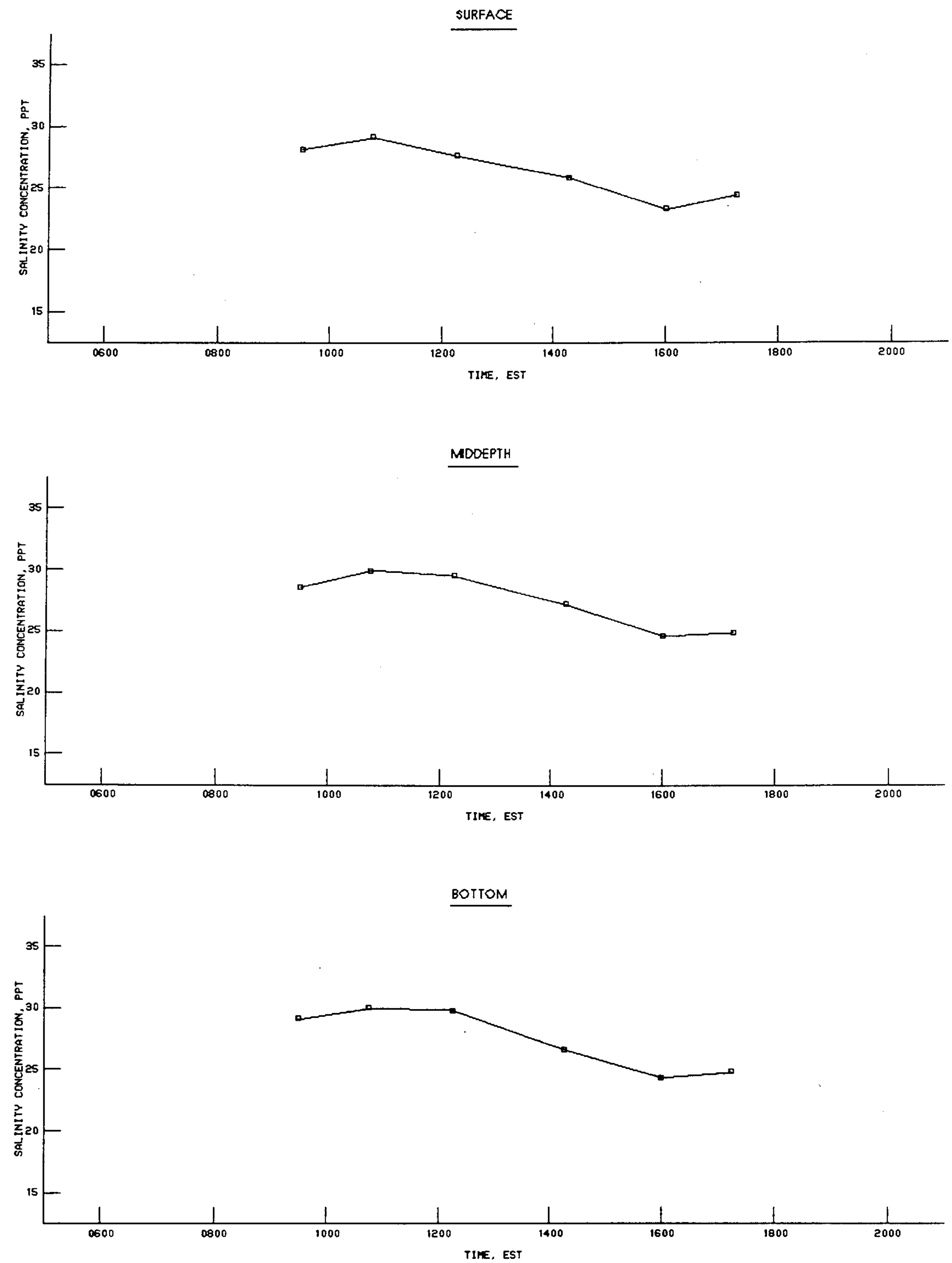
STATION 13.0B
08/19/93



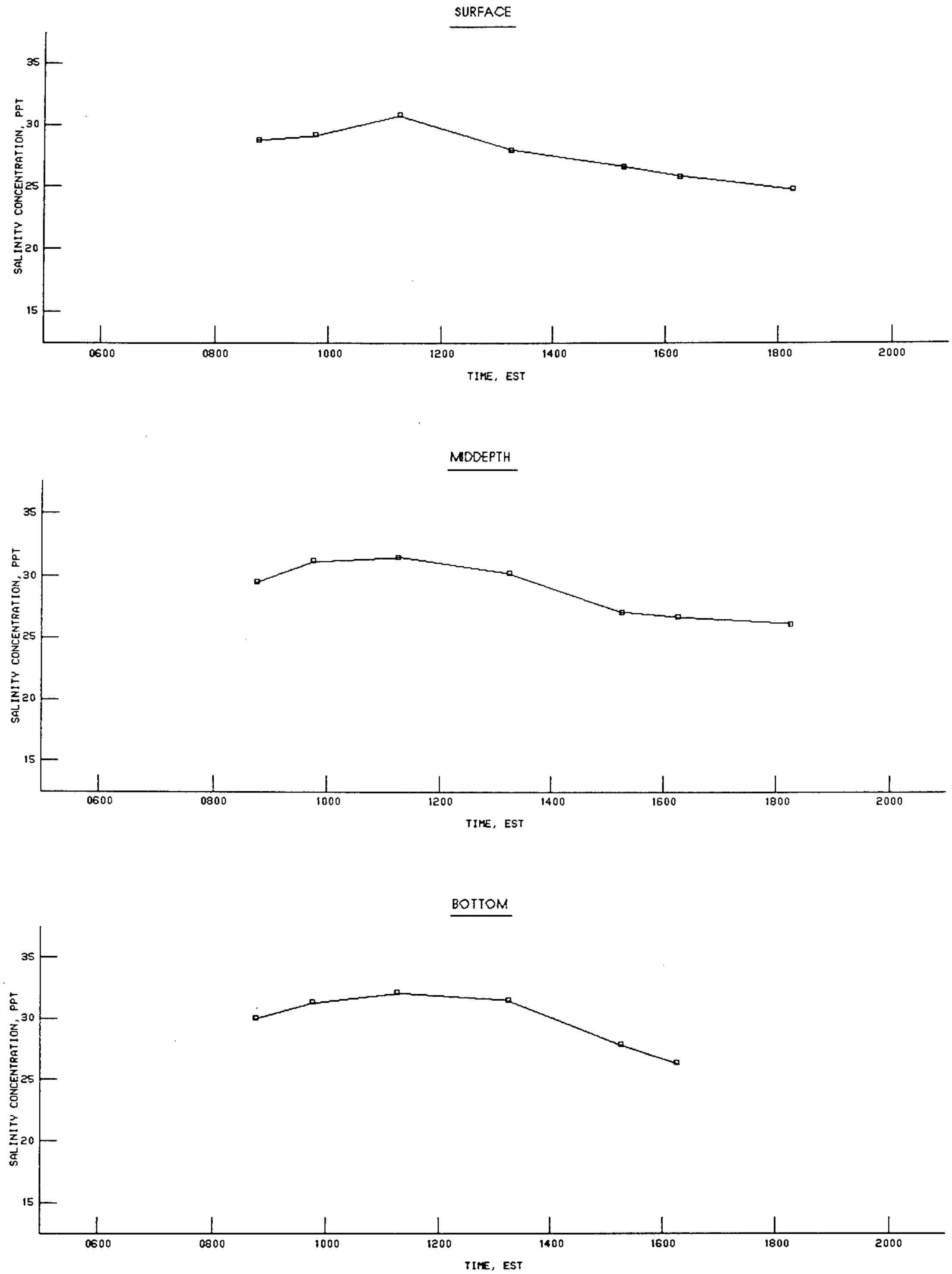




SALINITY CONCENTRATION
STATION NB1B
08/19/93

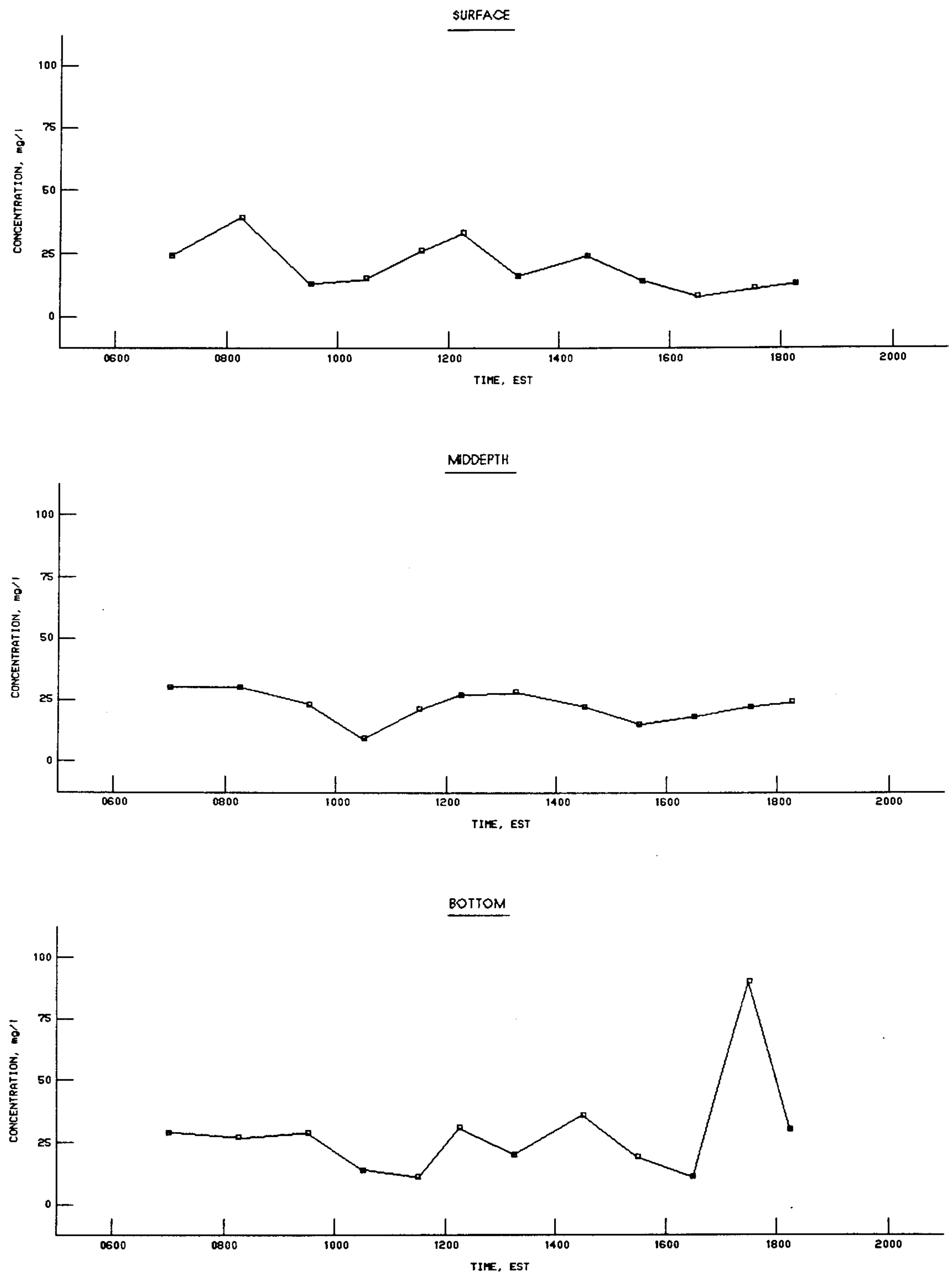


SALINITY CONCENTRATION
STATION CB2B
08/19/93

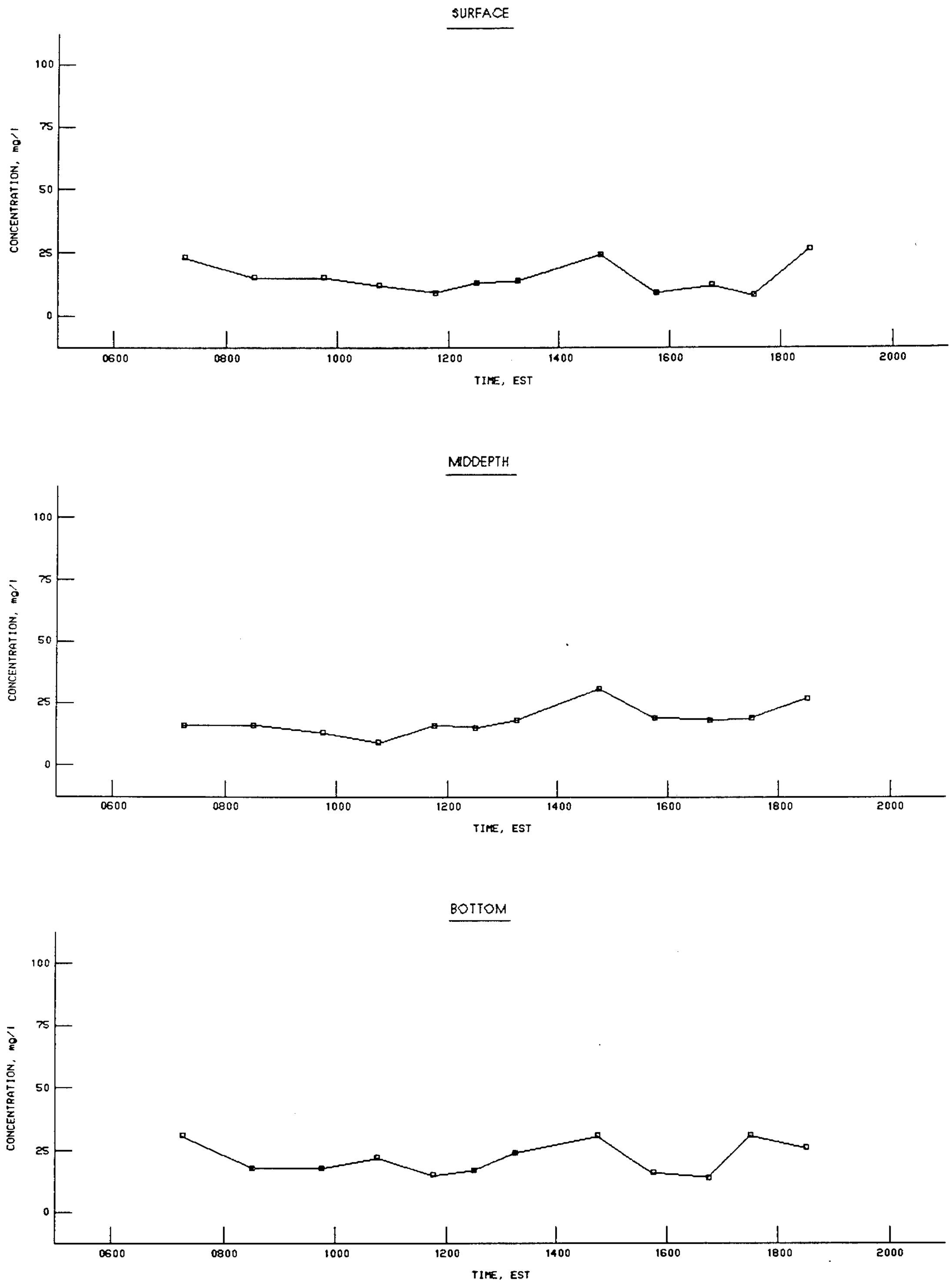


SALINITY CONCENTRATION
STATION SB1B
08/19/93

Plate 142



SUSPENDED SEDIMENT CONCENTRATIONS
STATION 1.0A
08/19/93



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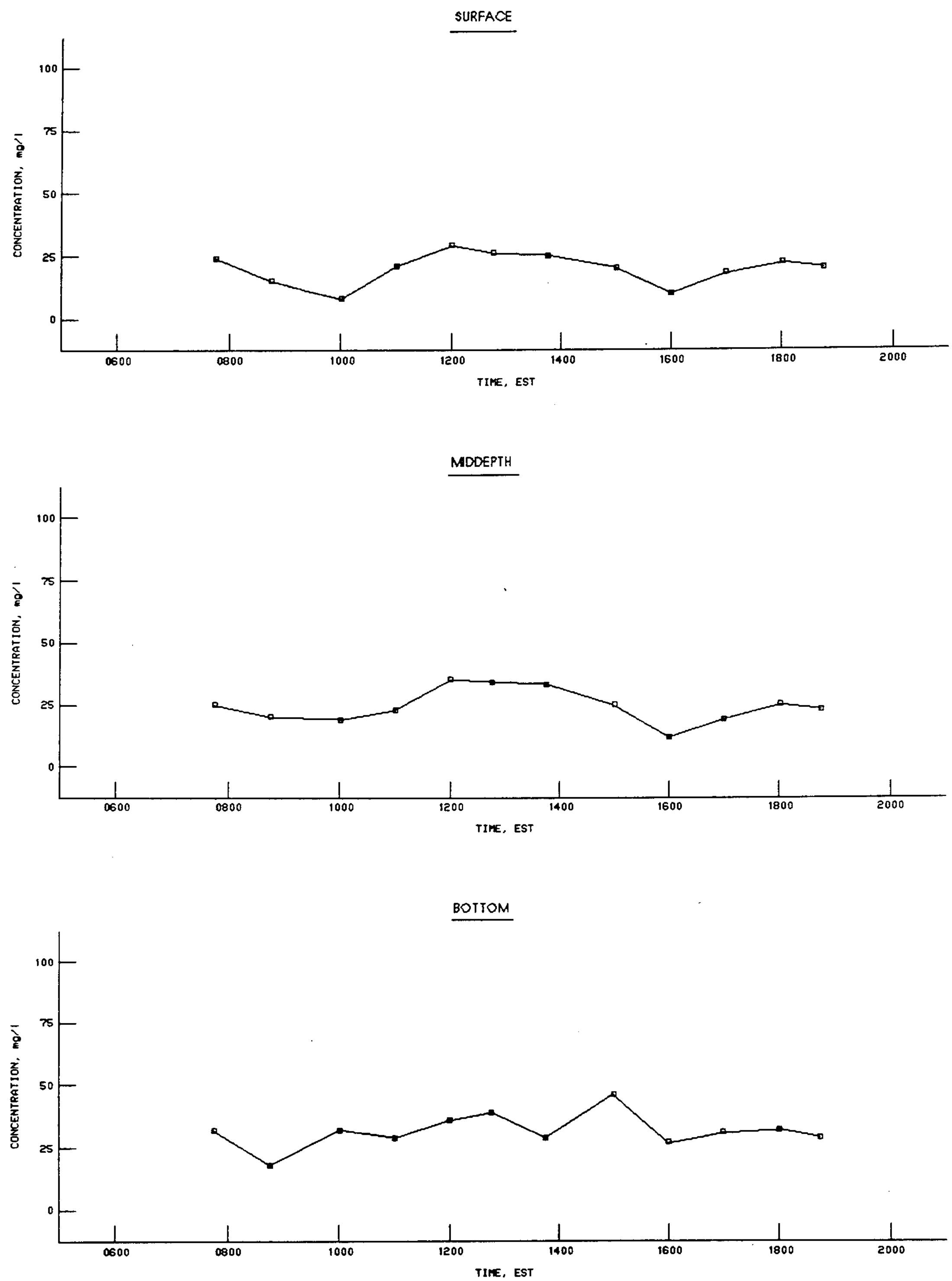
STATION 1.0C
08/19/93



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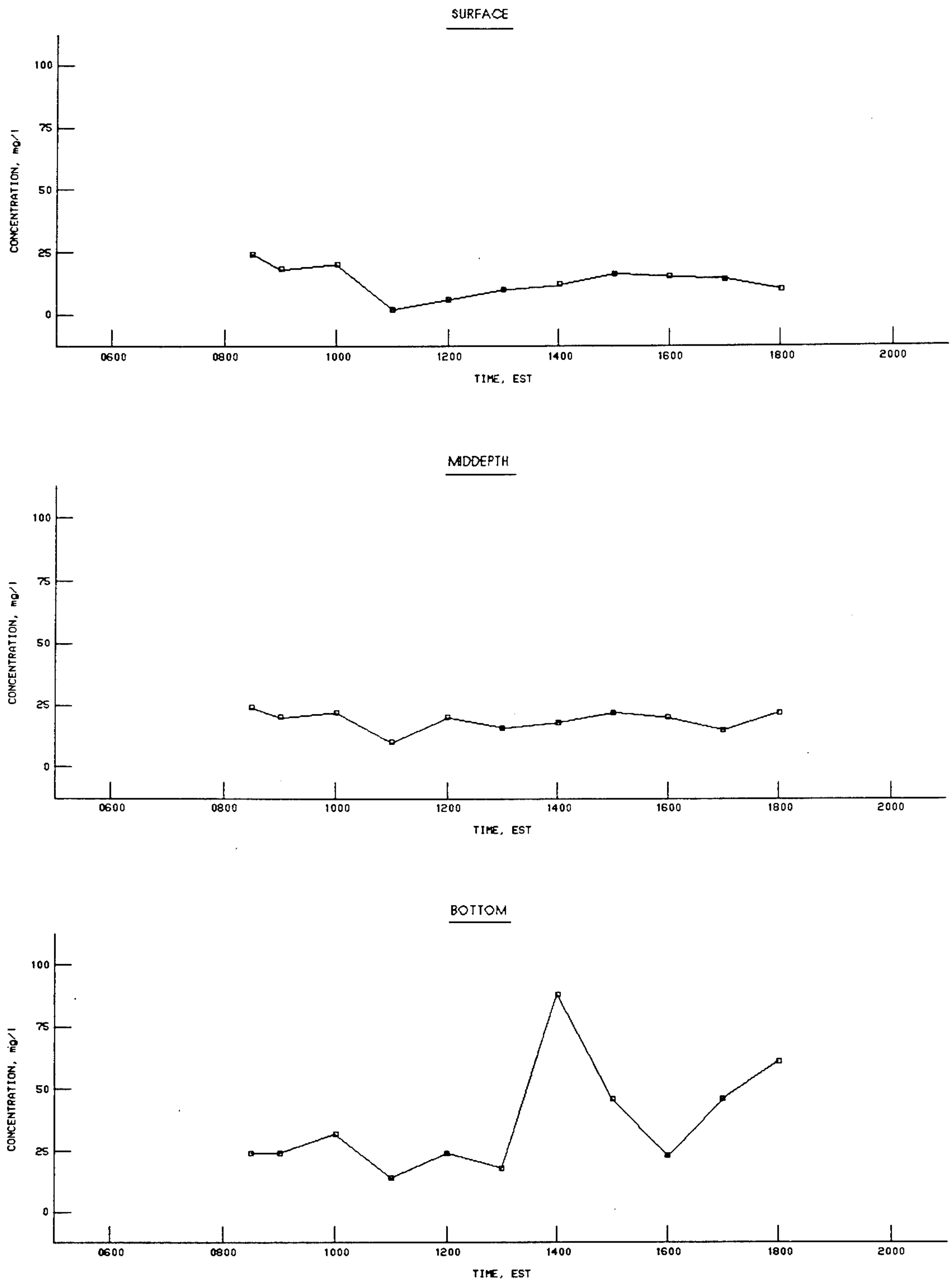

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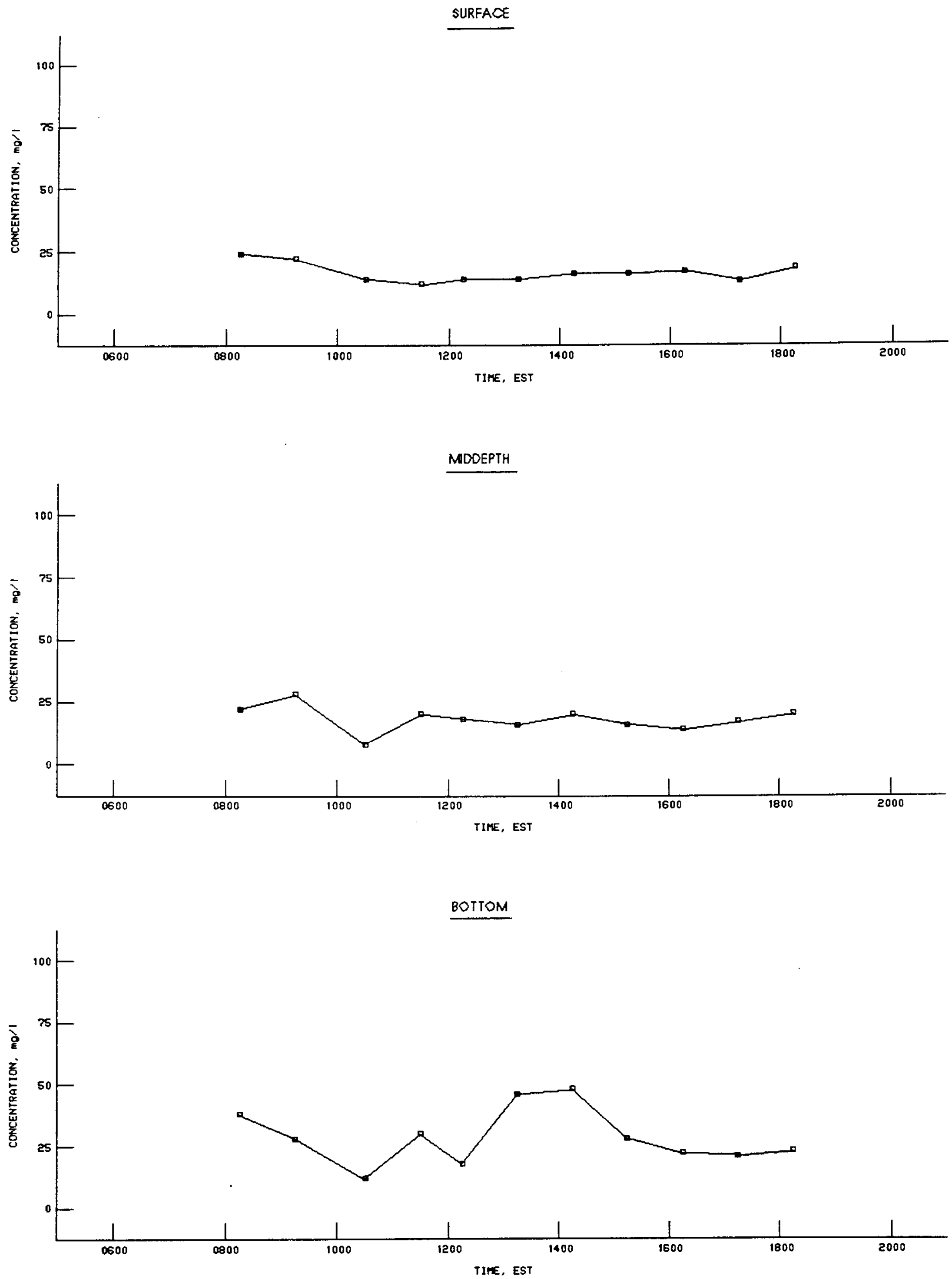

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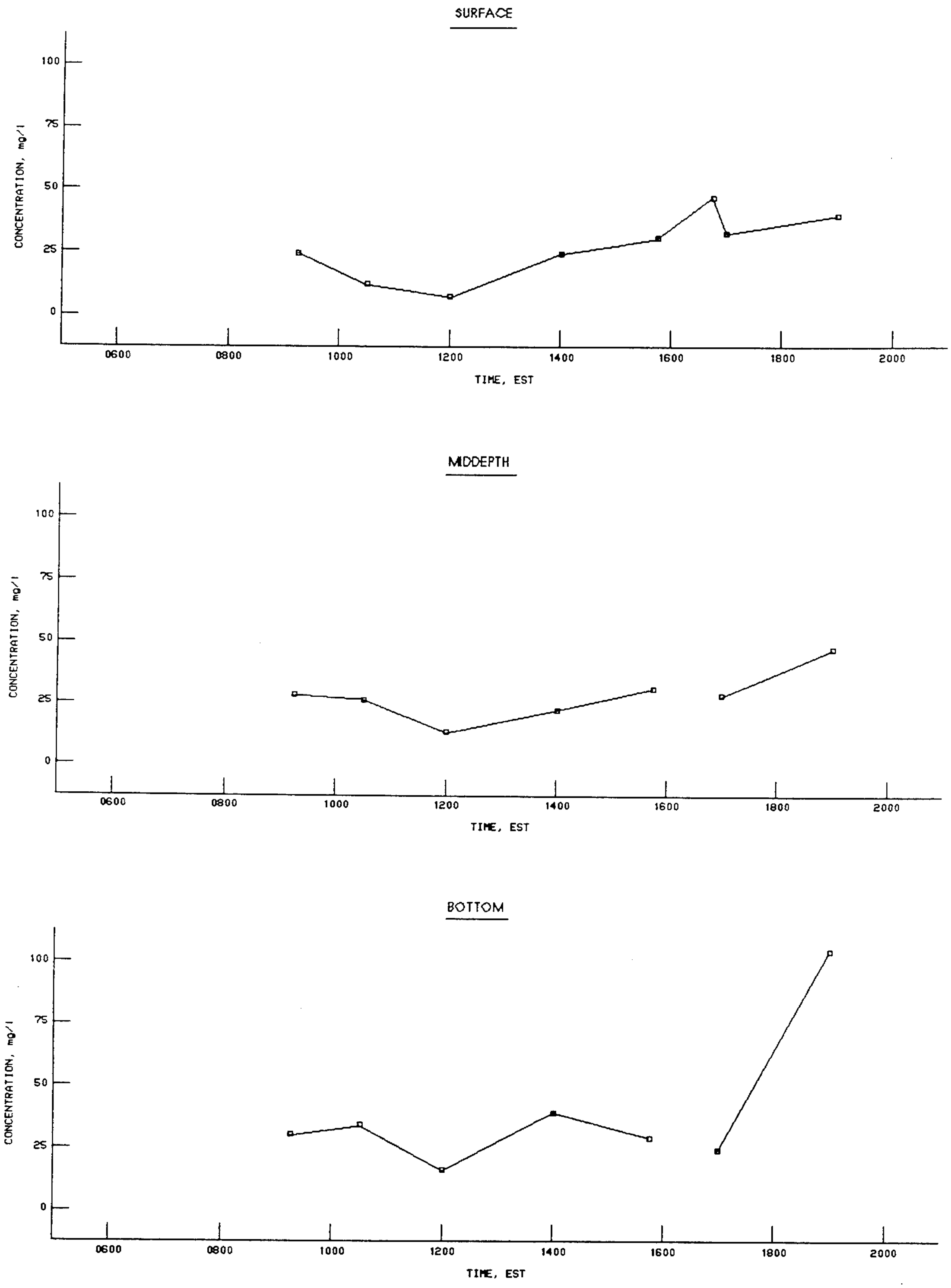
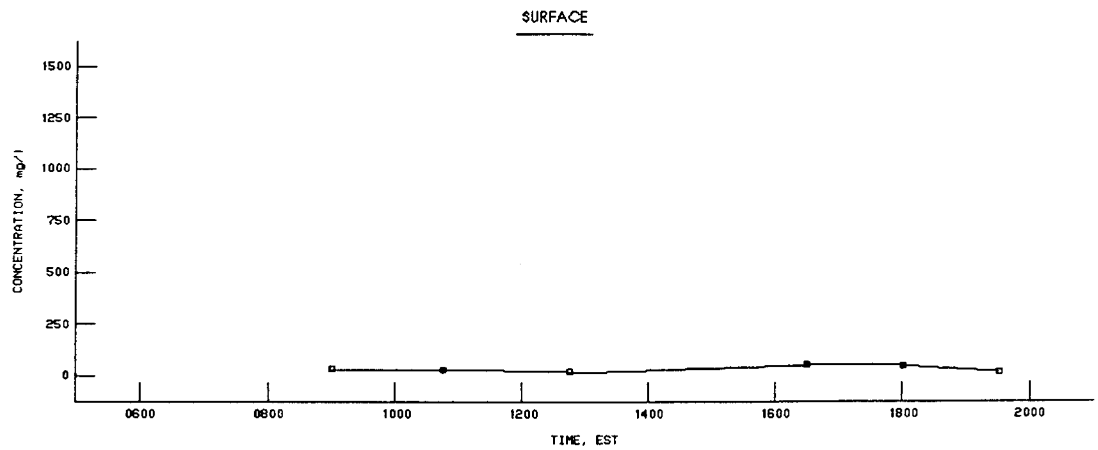
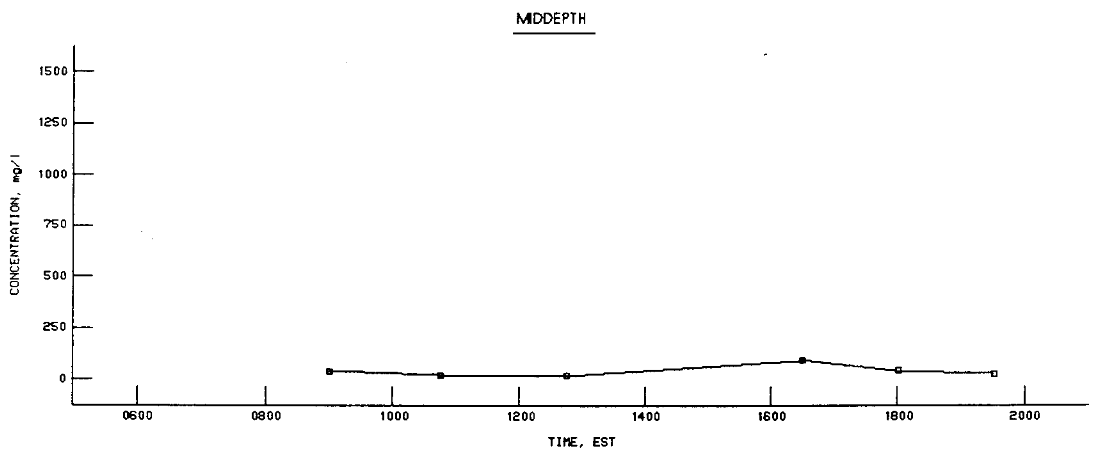
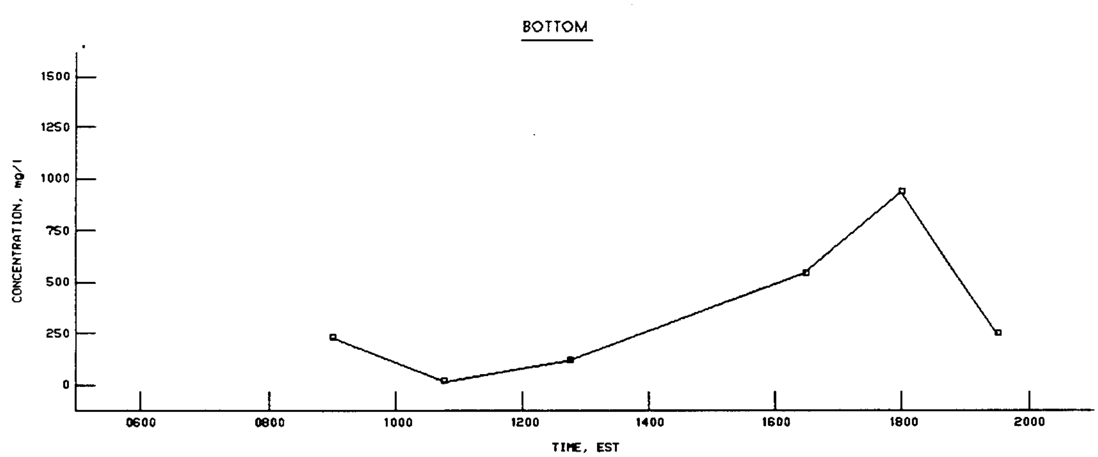


SUSPENDED SEDIMENT CONCENTRATIONS
STATION 4.0B
08/19/93

Plate 148







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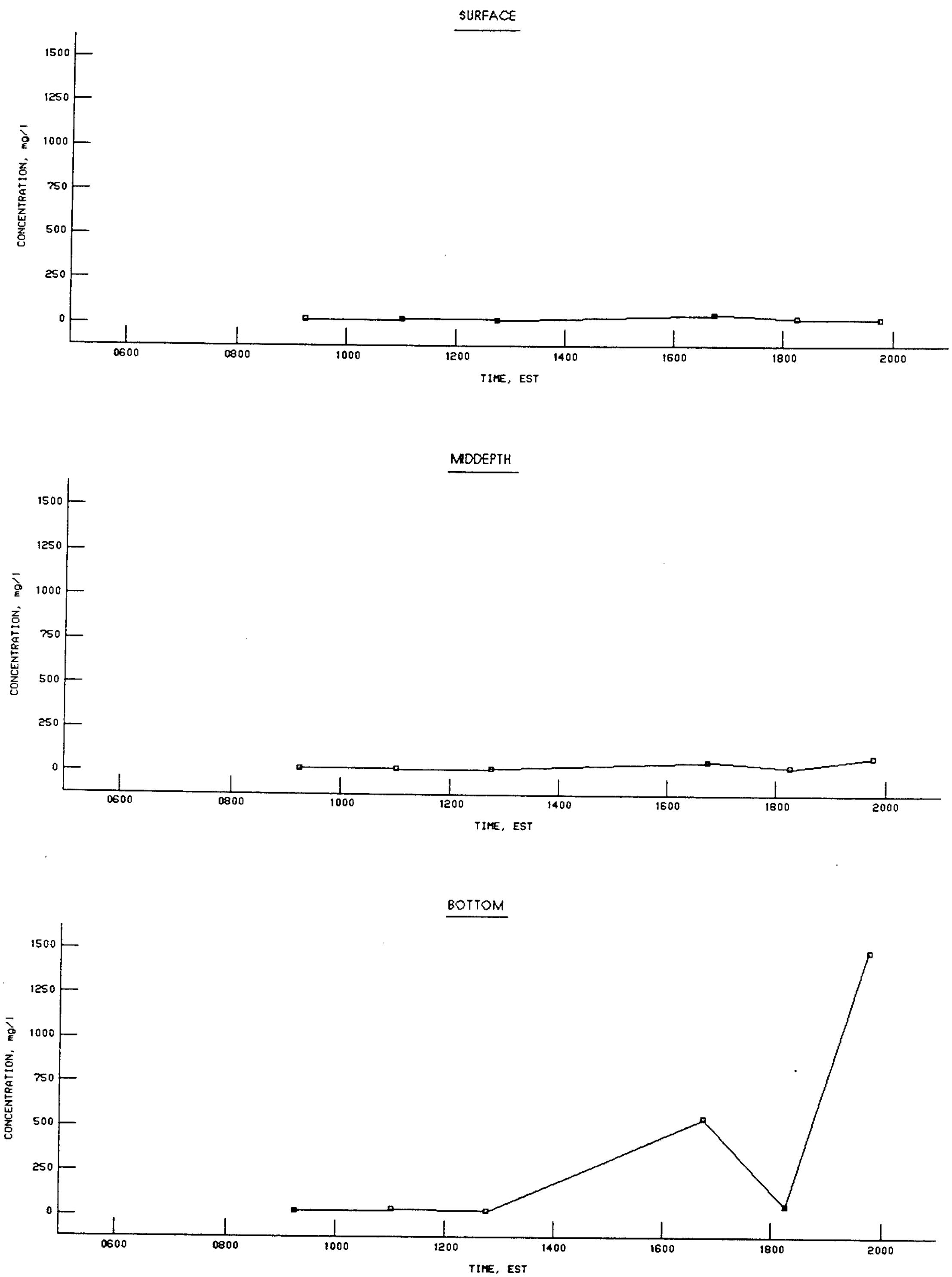
08/19/93



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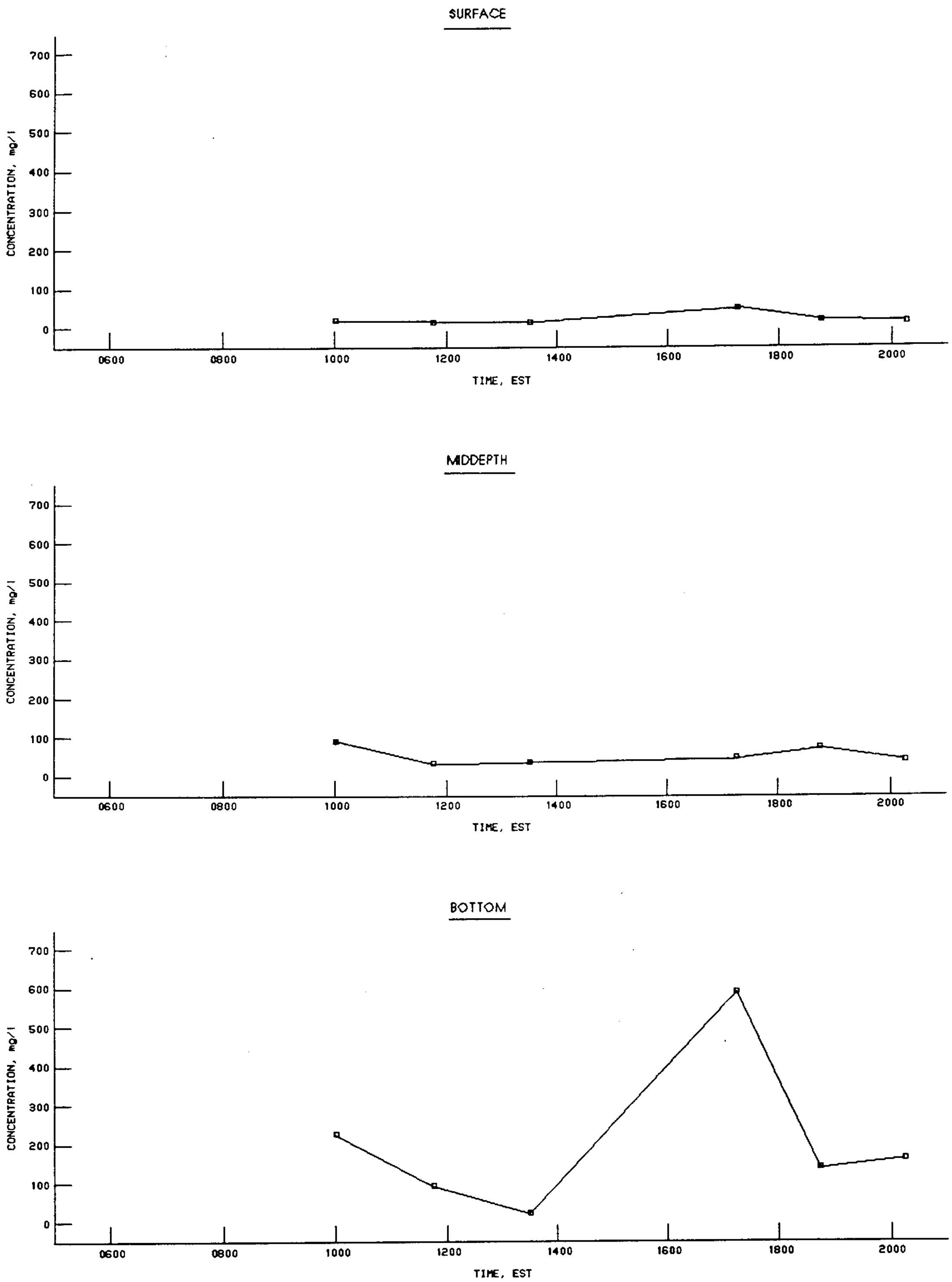
08/19/93



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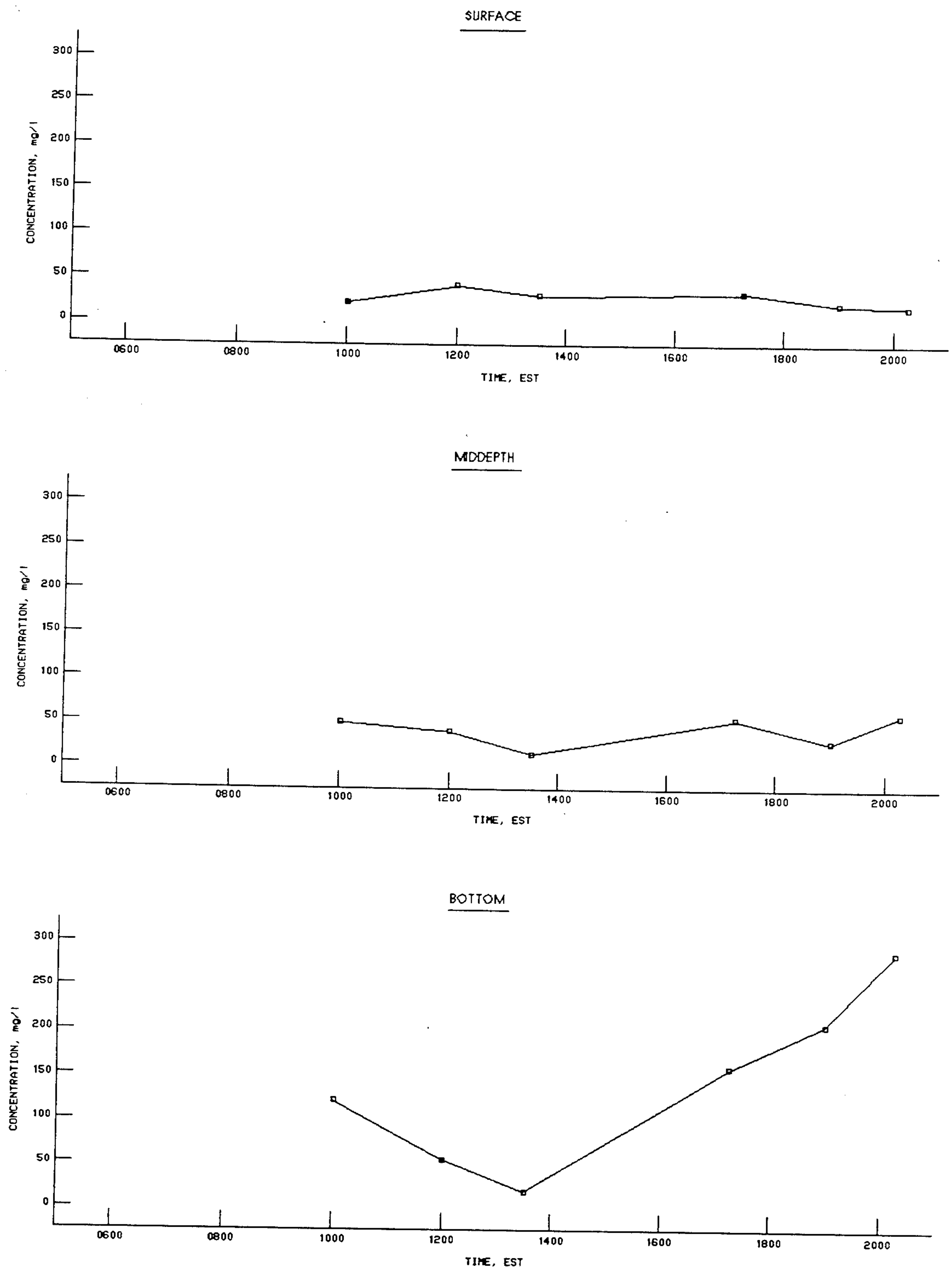
08/19/93



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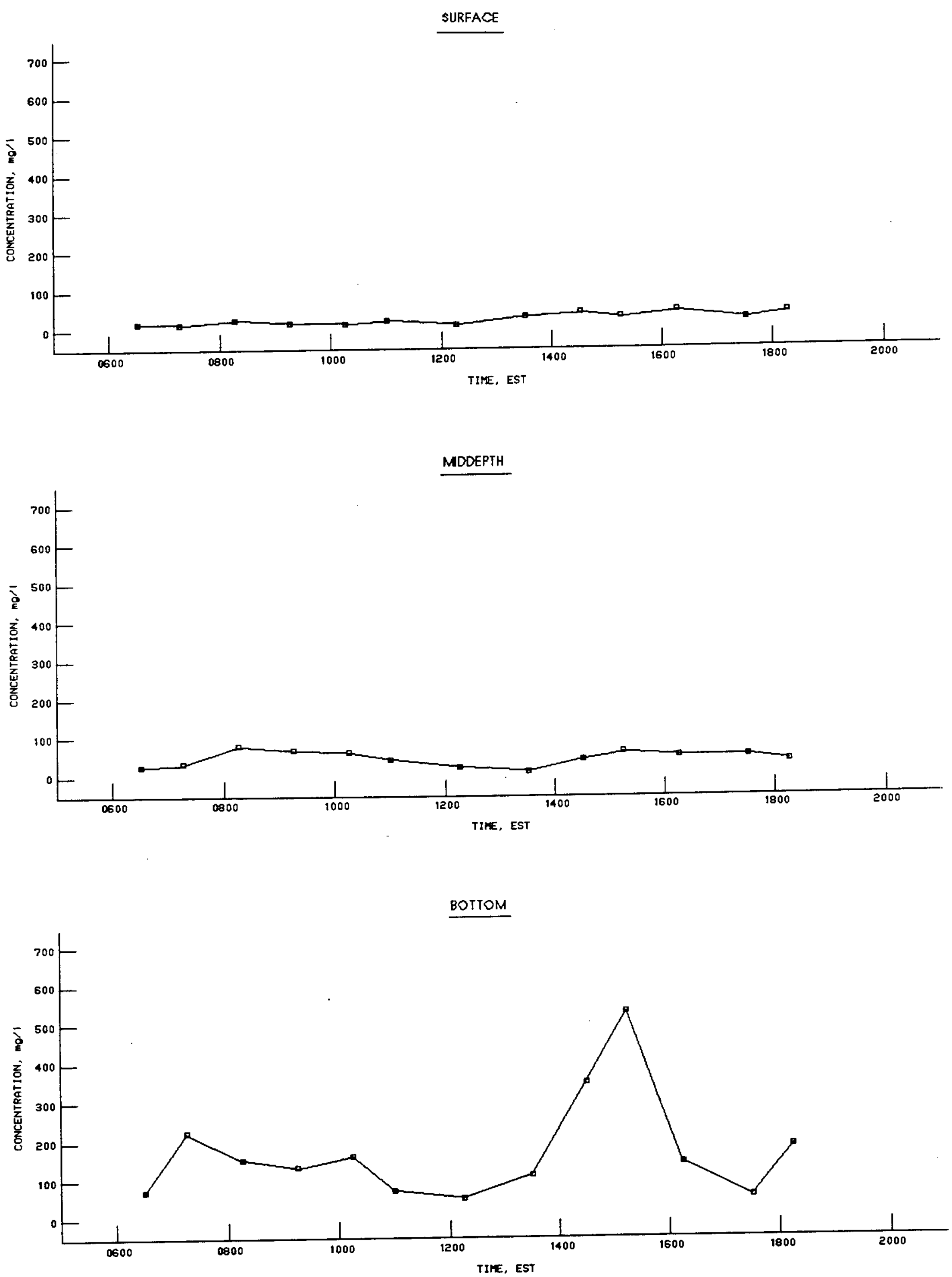

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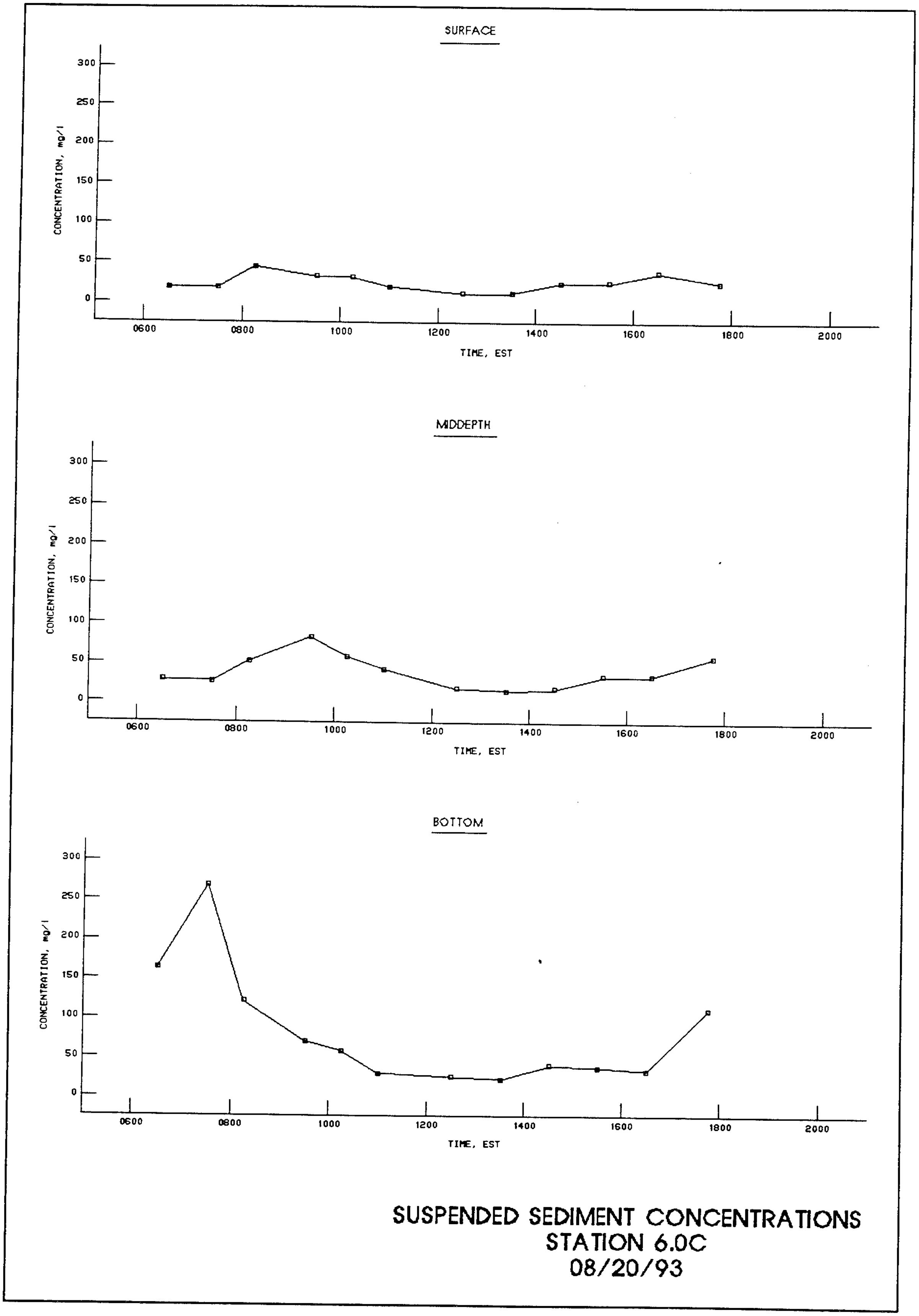
08/20/93


SURFACE
MIDDEPTH
BOTTOM
CONCENTRATION, mg/l
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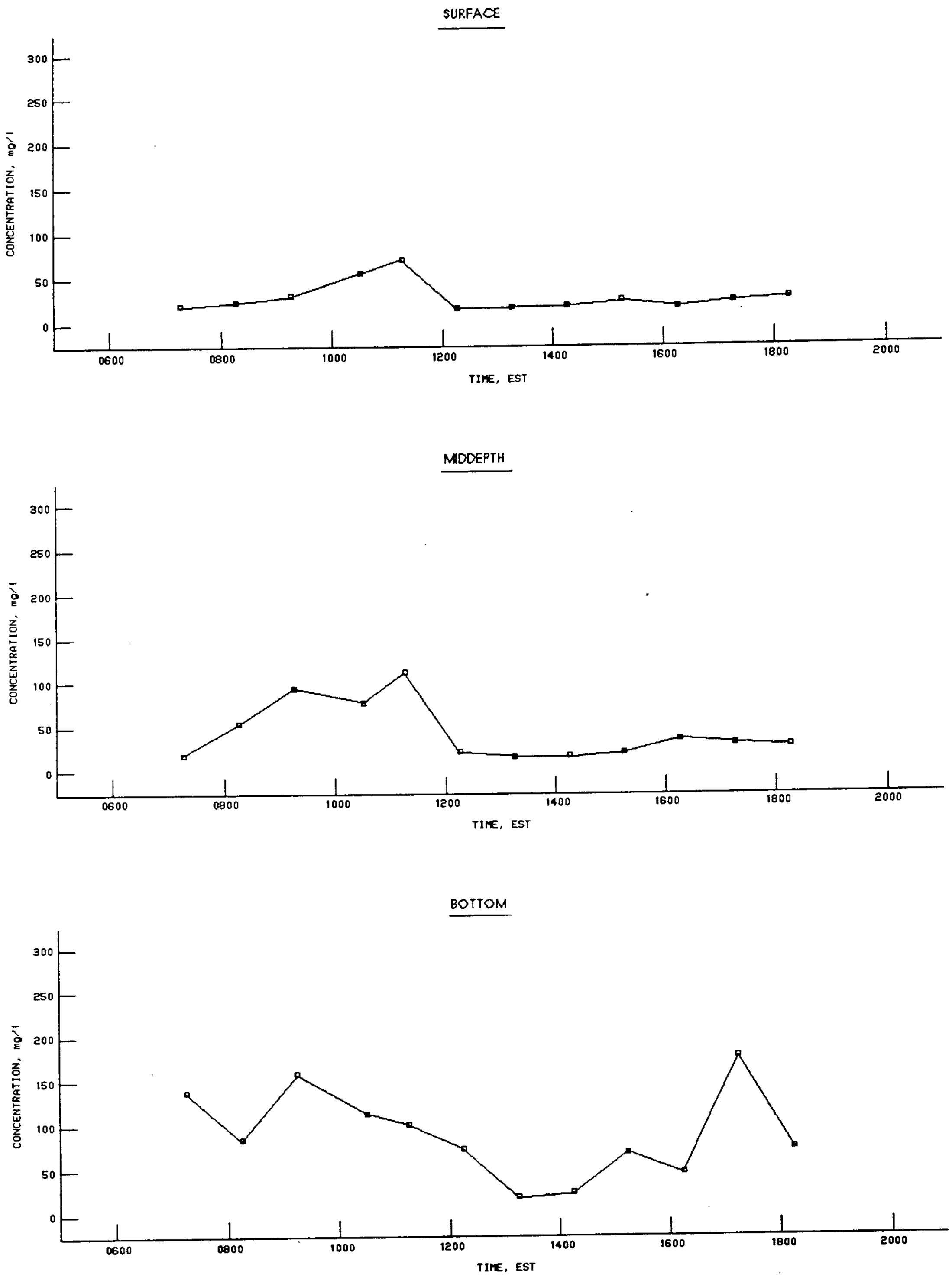
250
200
150
100
50
0
0600
0800
1000
1200
1400
1600
1800
2000
TIME, EST
SUSPENDED SEDIMENT CONCENTRATIONS
STATION 6.0C
08/20/93



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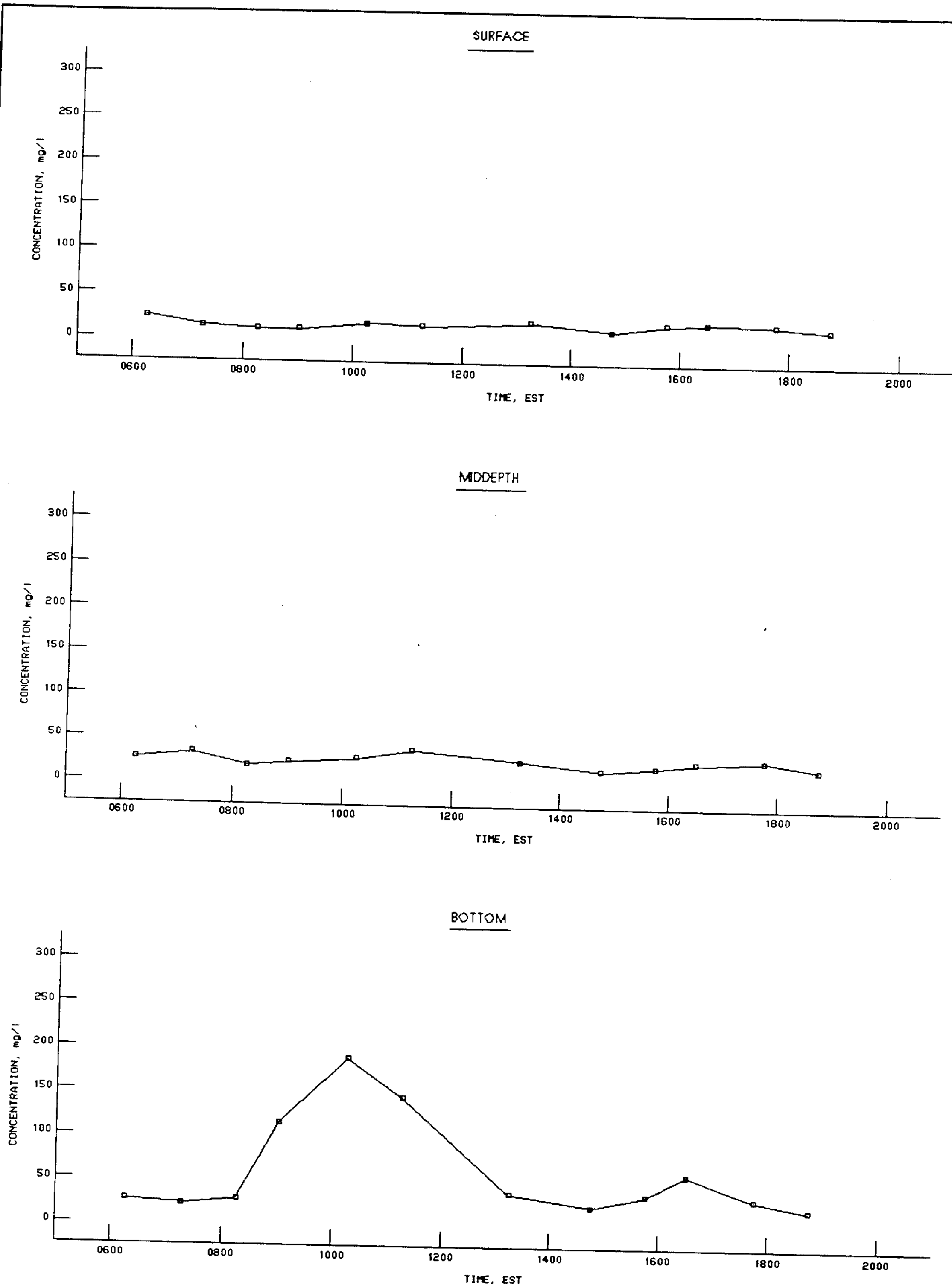
08/20/93



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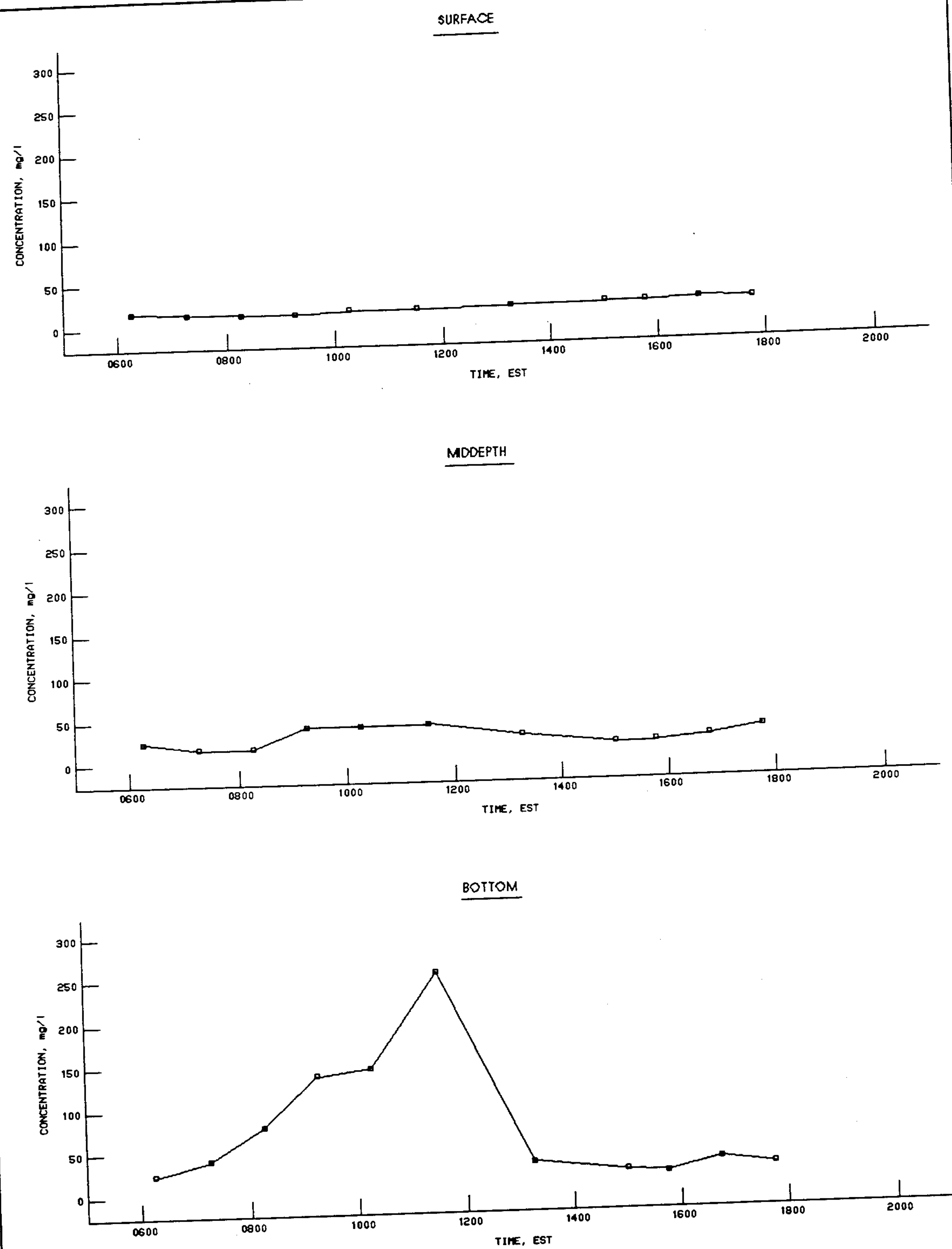
08/20/93



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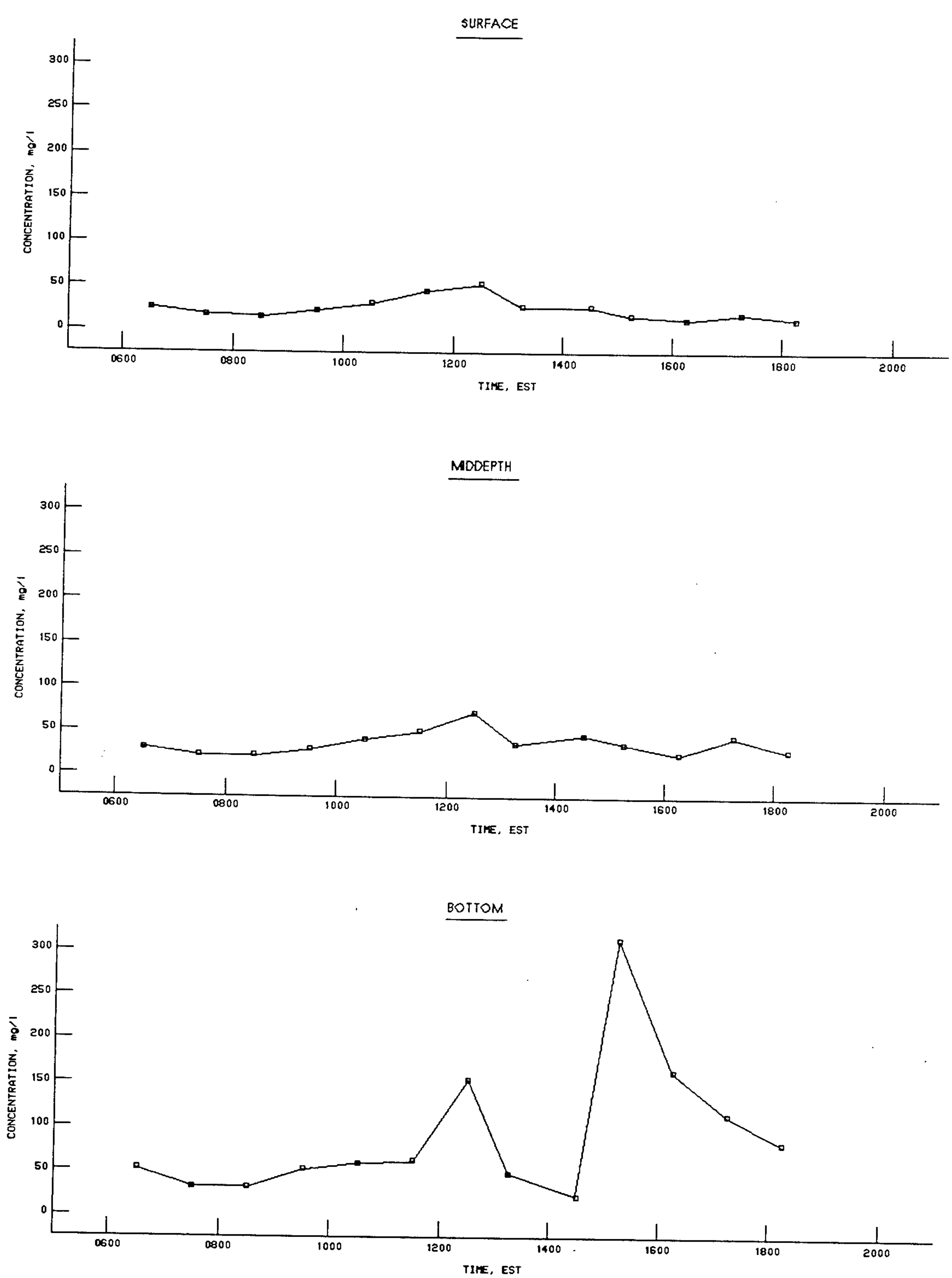
STATION 8.0C
08/20/93



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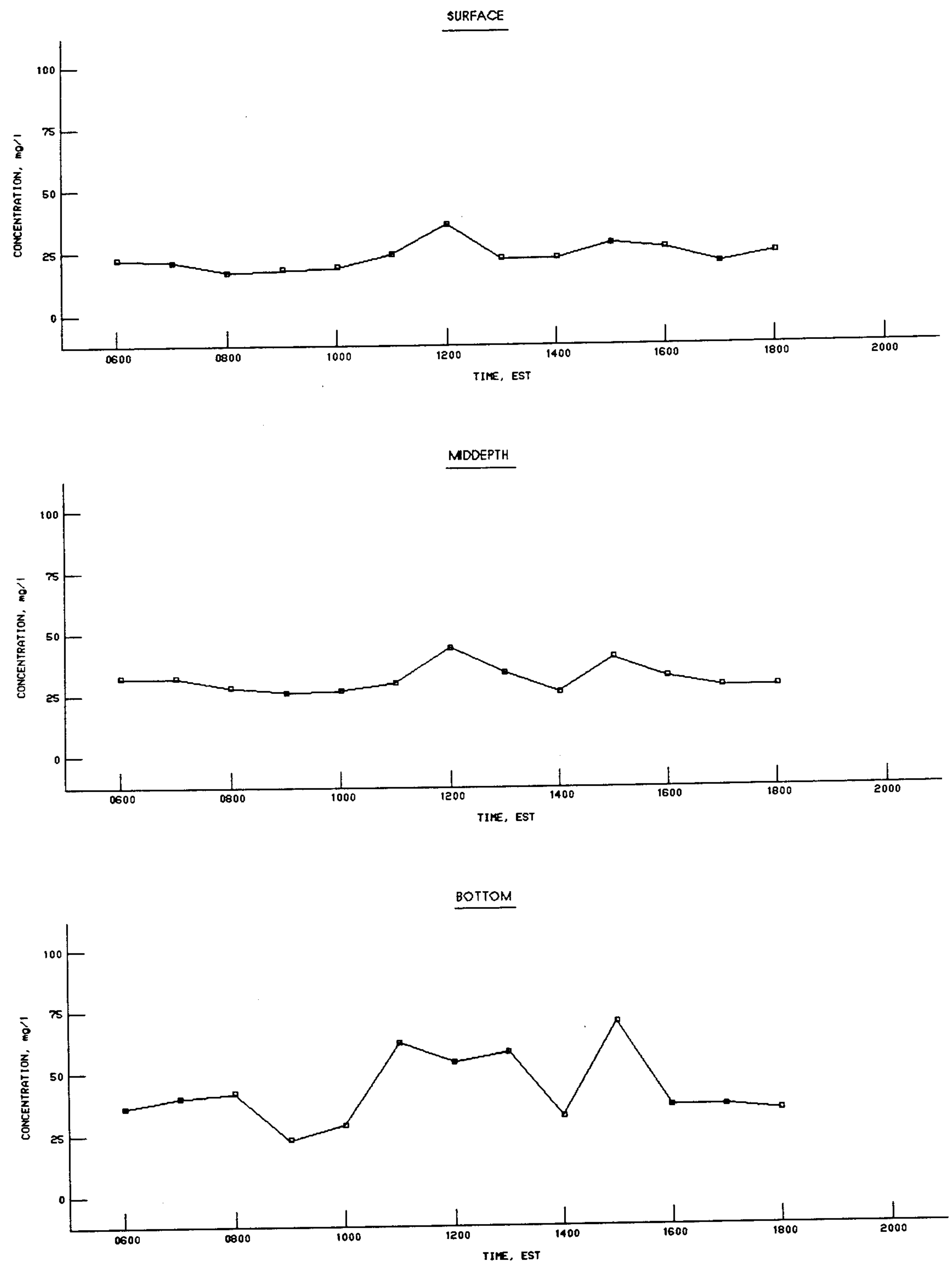

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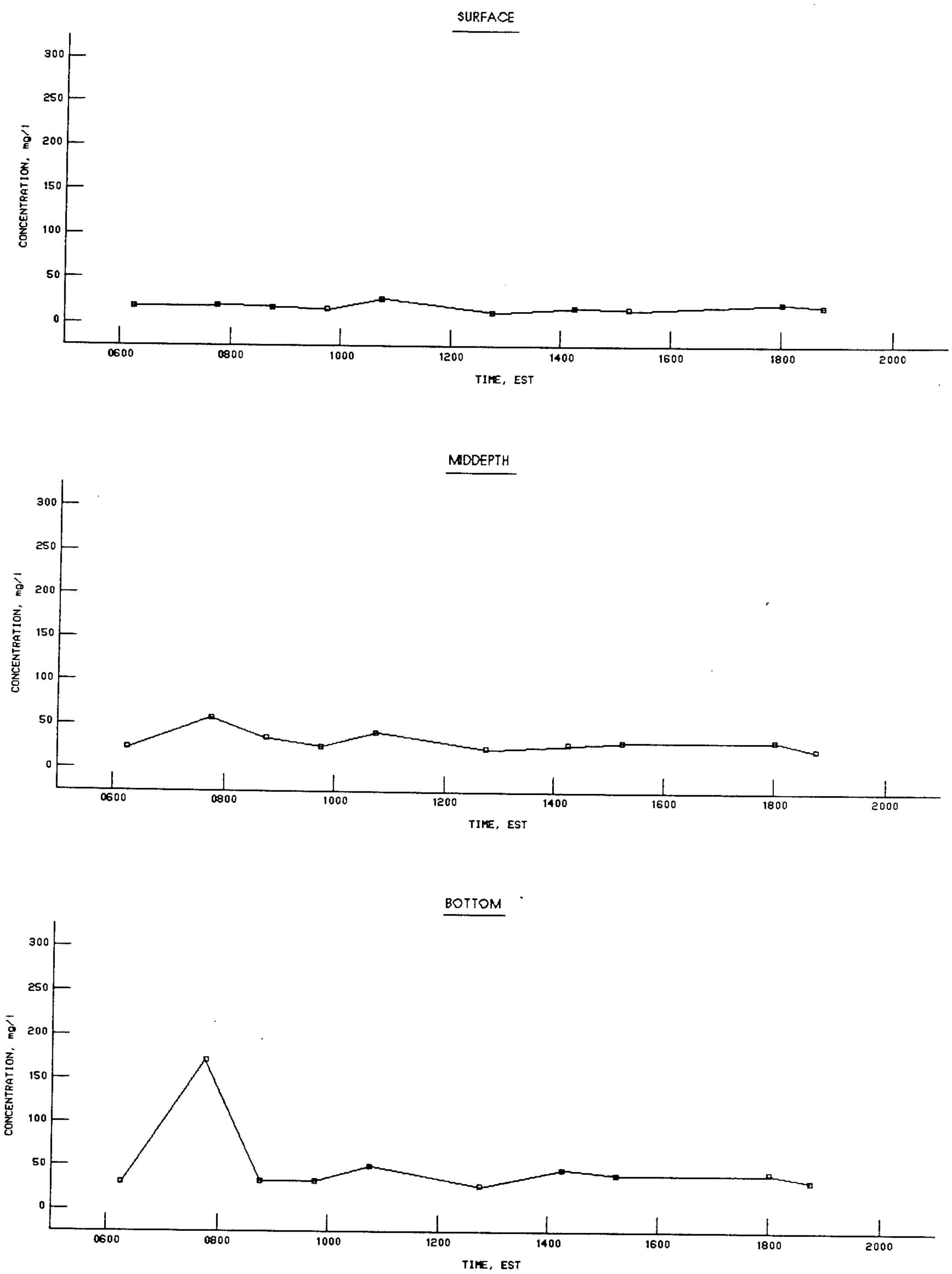

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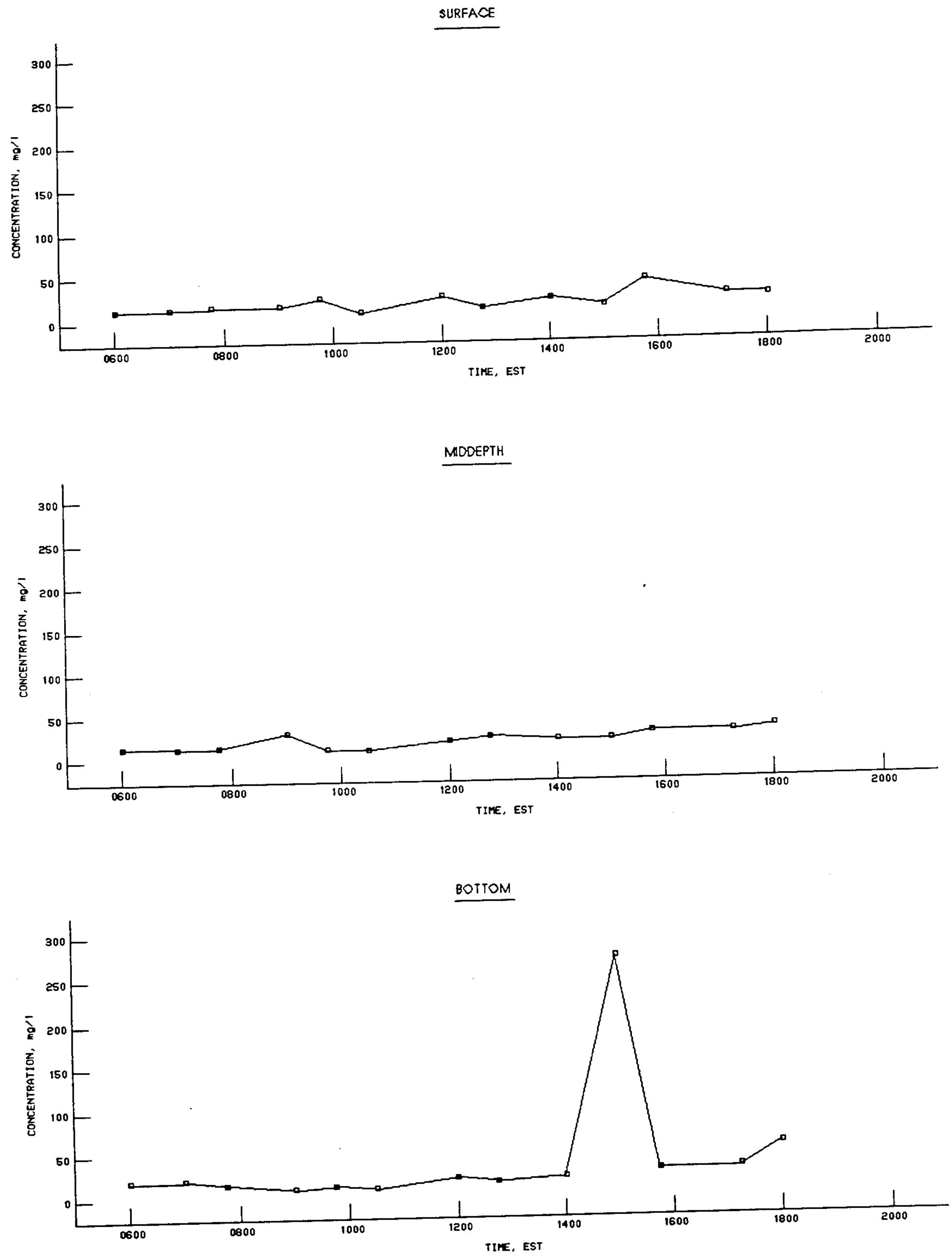

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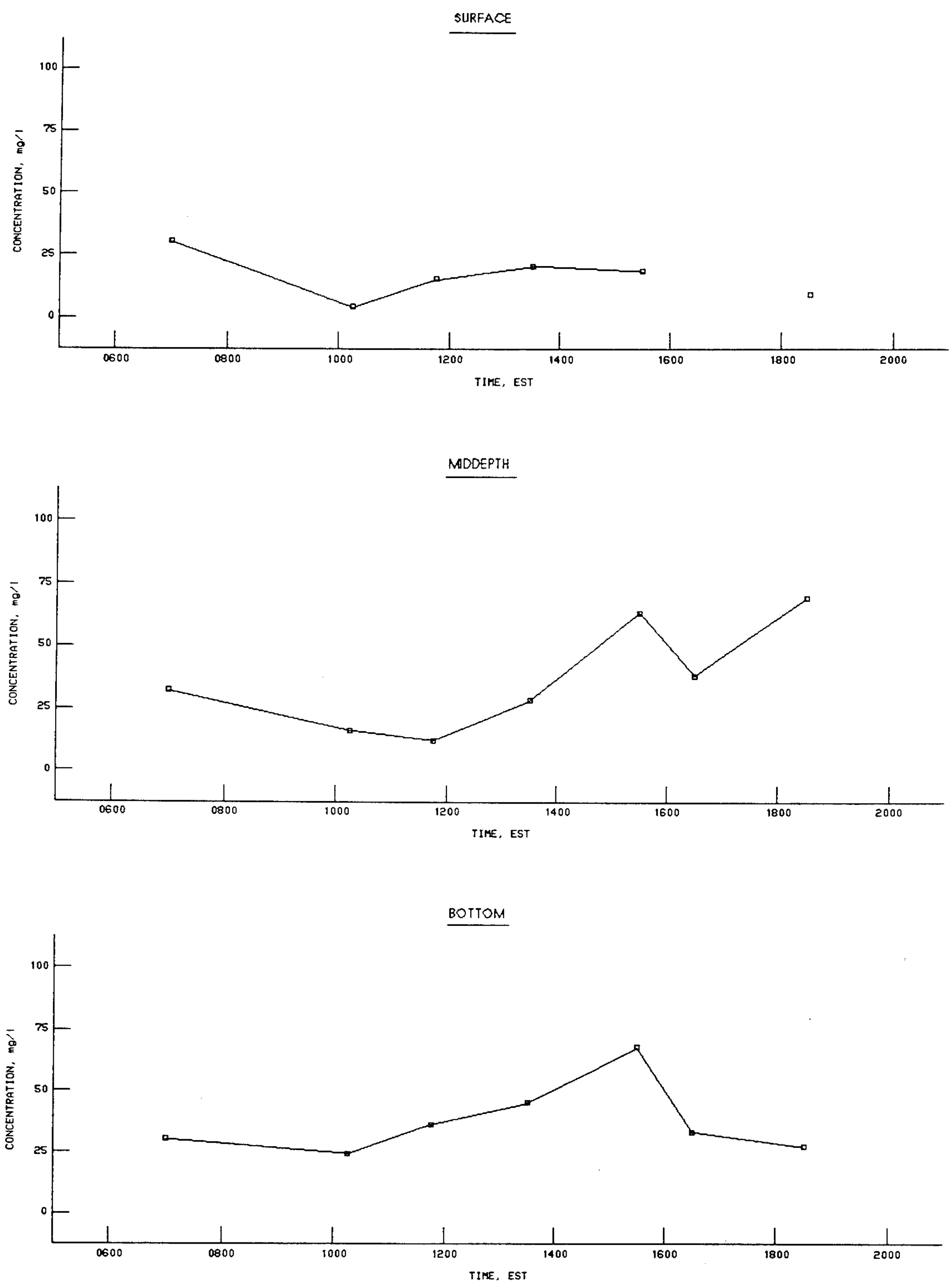

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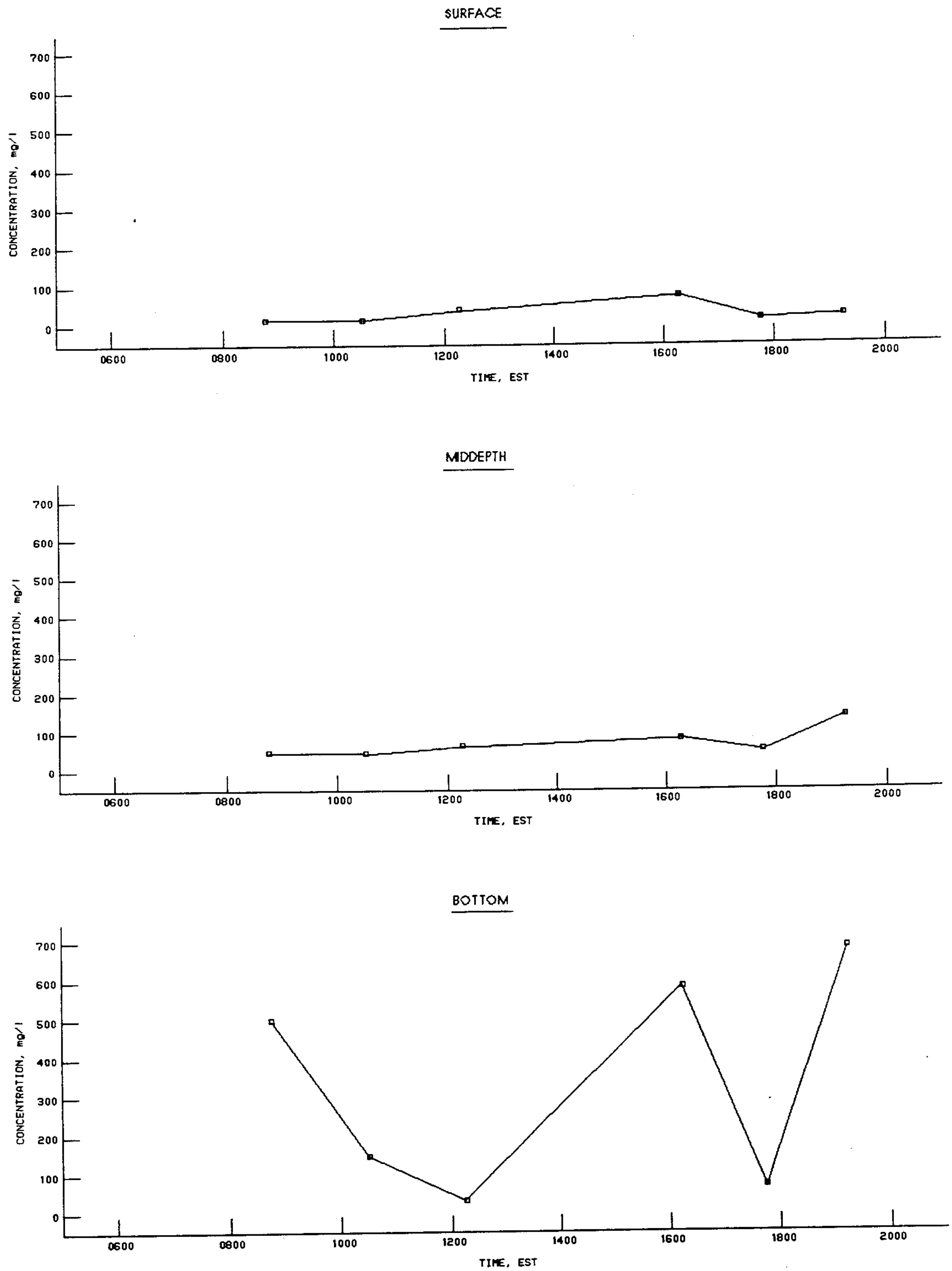
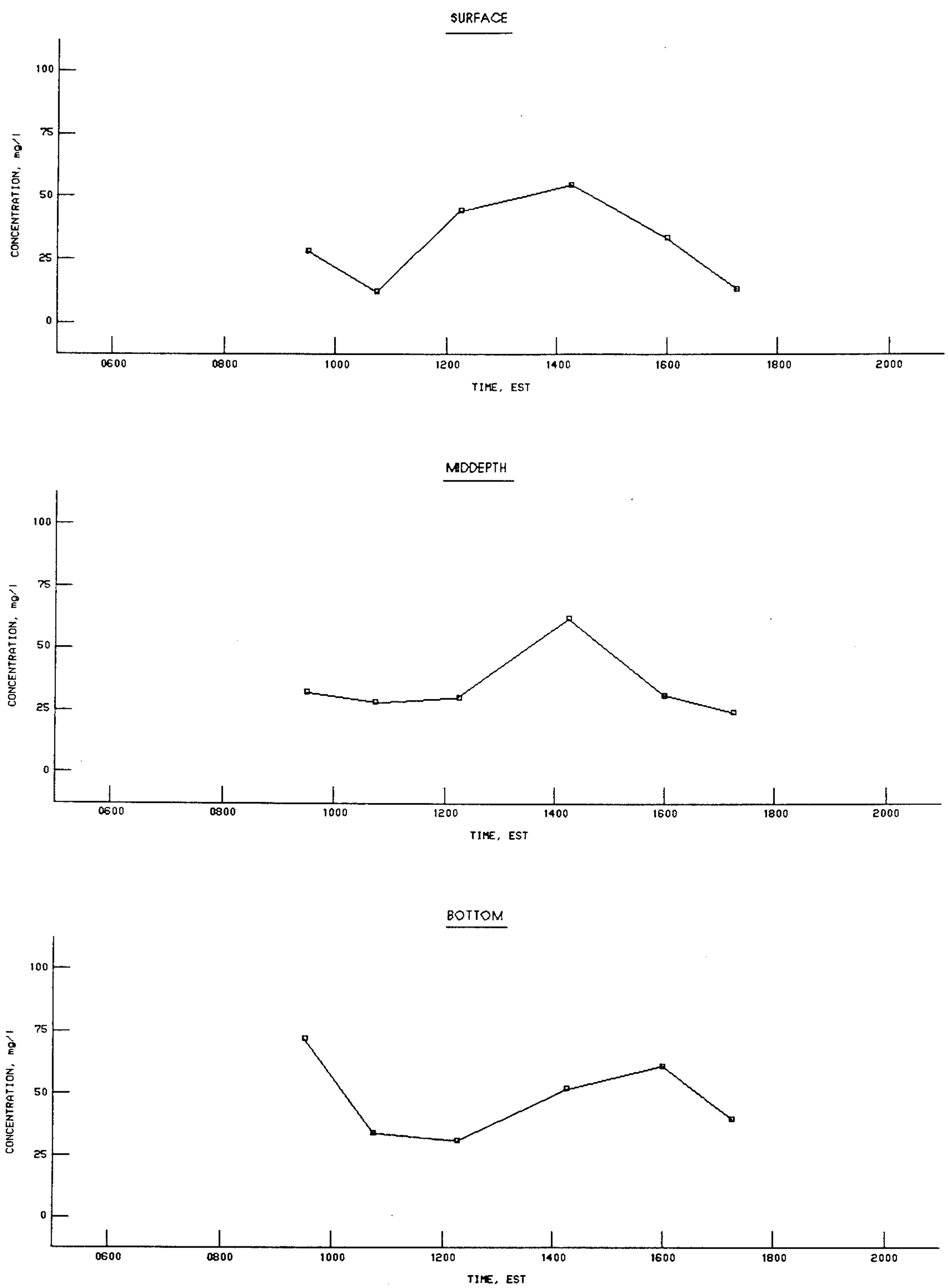
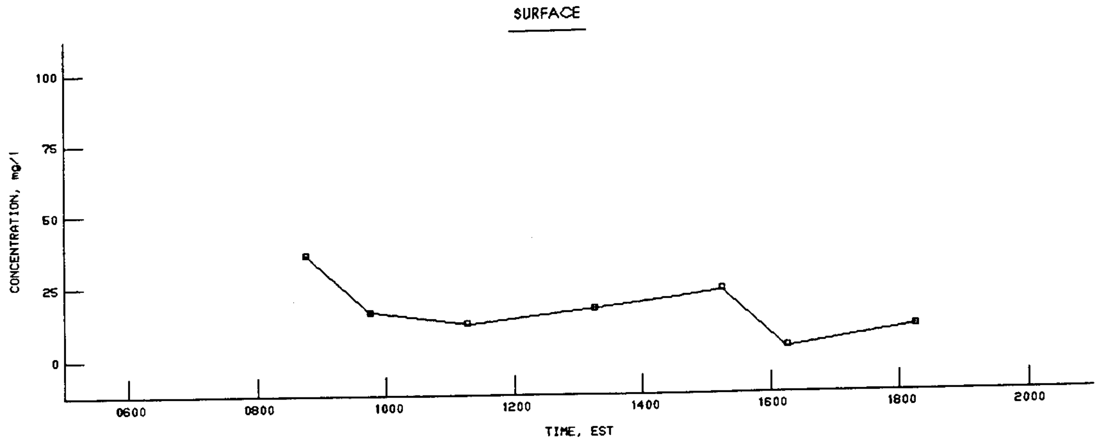
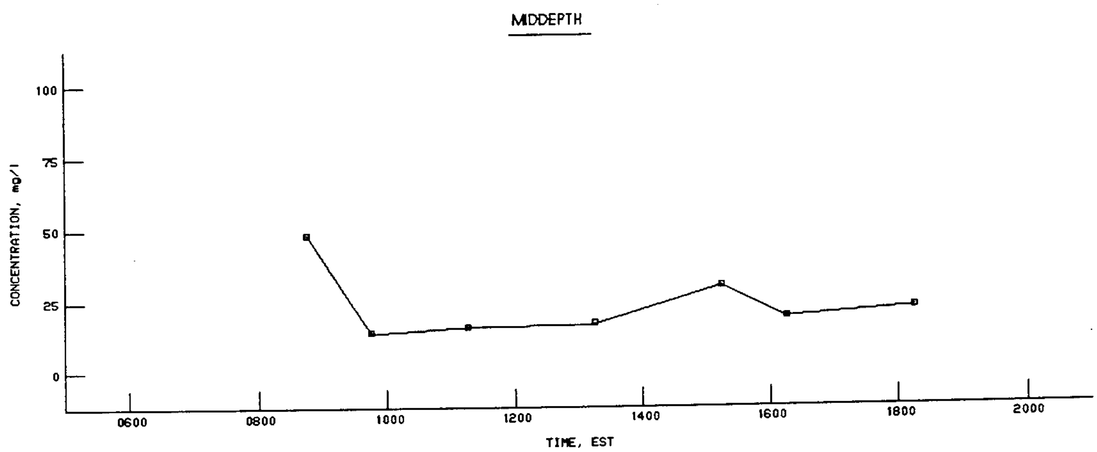


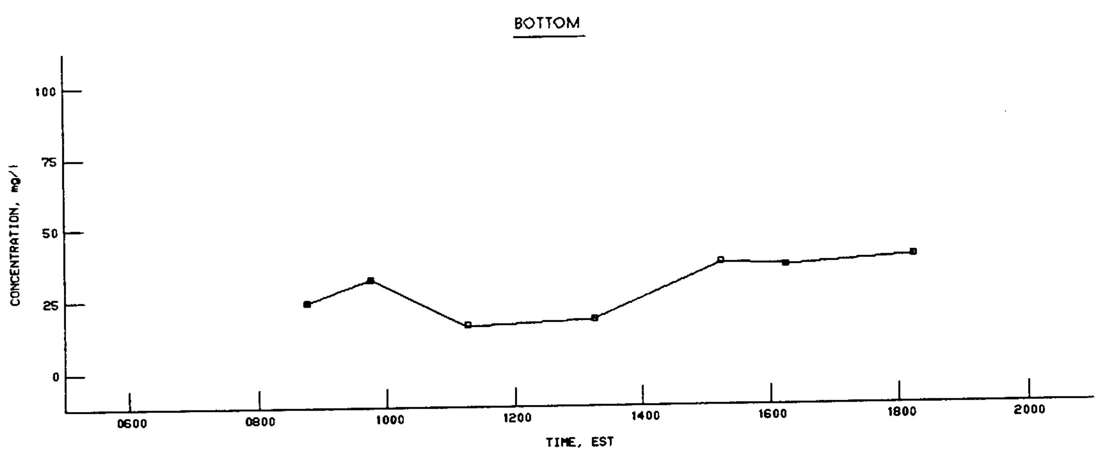
SUSPENDED SEDIMENT CONCENTRATIONS
STATION NB1B
08/19/93



SUSPENDED SEDIMENT CONCENTRATIONS
STATION CB2B
08/19/93







SUSPENDED SEDIMENT CONCENTRATIONS
STATION SB1B
08/19/93

Appendix A
Prototype and Field Studies Group Data Collection Equipment and Laboratory Analysis Procedures

This appendix provide detailed information on the types of data collection and laboratory equipment used in a majority of the field investigations performed by the Prototype and Field Studies Group, Hydraulics Laboratory (HL), U.S. Army Engineer Waterways Experiment Station (USAEWES). The following listing identifies the parameters most commonly measured and the types of instruments that can provide these measurements.

Current Velocity and Direction Measurements

Recording velocity meters

Self-contained recording current meters are used to obtain current velocity and direction measurements for both profiling and for long-term fixed-depth deployment. One type of equipment commonly used is the Environmental Devices Corporation (ENDECO) Type 174 SSM current meter as shown in Figure A1. The ENDECO 174 SSM meter is tethered to a stationary line or structure and floats in a horizontal position at the end of the tether (as shown

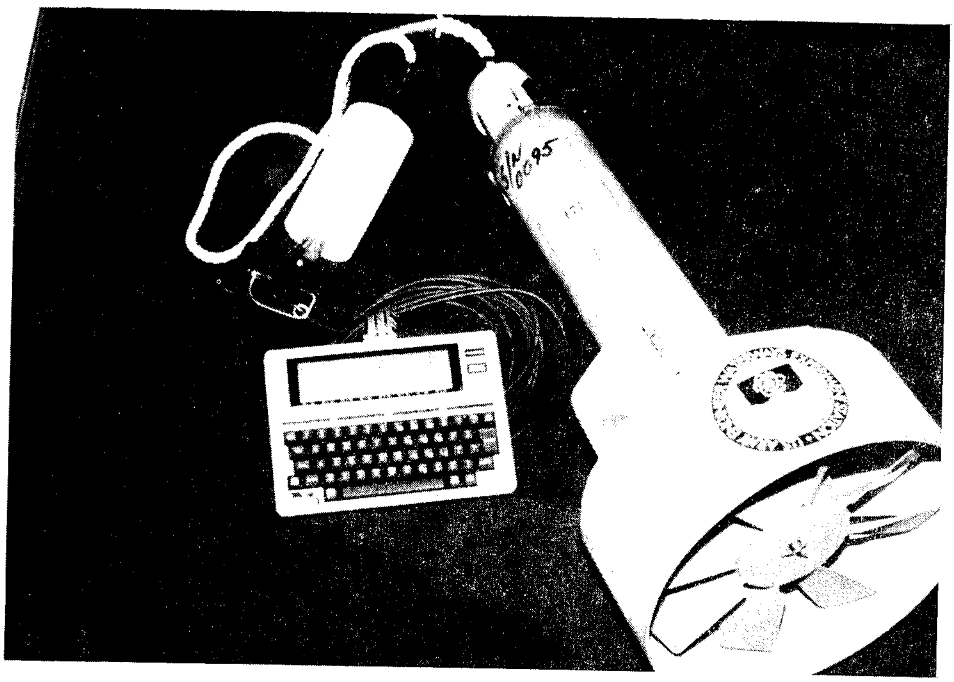


Figure A1. ENDECO 174 SSM recording current meter

in Figure A2). It measures current speed with a ducted impeller and current direction with an internal compass. The ENDECO 174 SSM also measures temperature with a thermilinear thermistor and conductivity with an induction type probe. Data are recorded on an internal solid-state memory datalogger. Data are offloaded from the meter data logger by a communication cable connected between the meter and a computer. The threshold speed is less than 0.08 fps, maximum speed of the unit used is 8.44 fps (10 knots), and stated speed accuracy is ±3 percent of full scale. The manufacturer states that direction accuracy is ±7.2 deg above 0.08 fps. Time accuracy is ±4 sec per day.

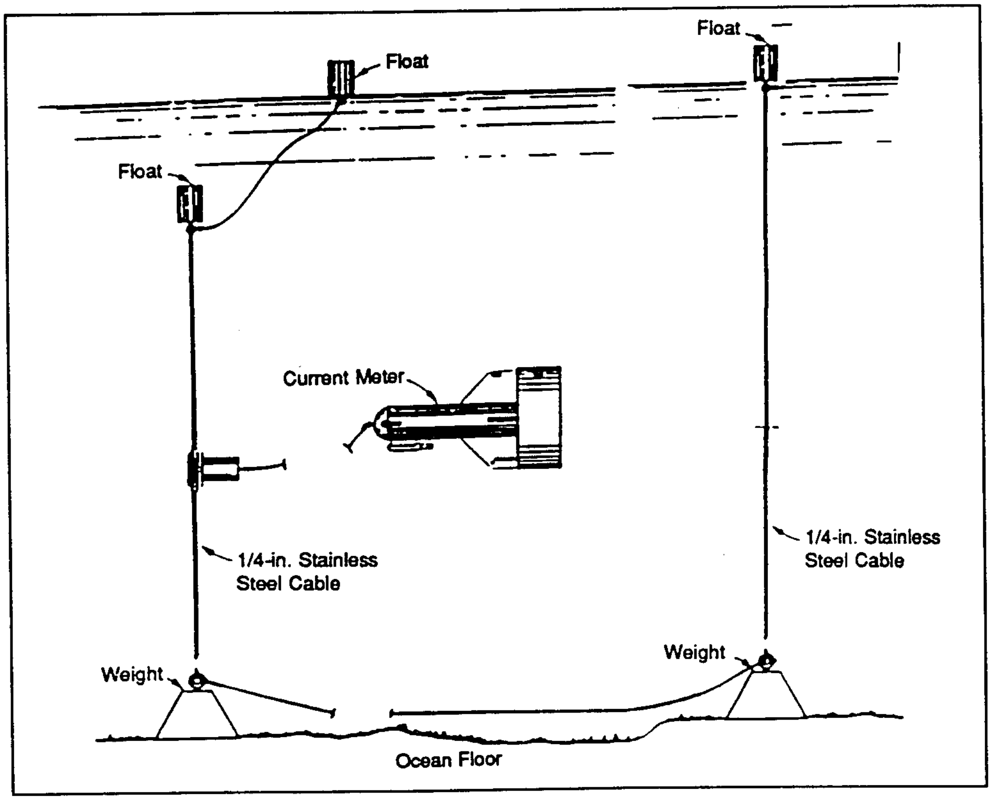


Figure A2. Typical deployment technique for fixed depth velocity measurements

Acoustic Doppler Current Profiler (ADCP)

Acoustic techniques are used to obtain current velocity and direction measurements for fast and accurate profiling in the field. The equipment used is an RD Instruments Broad-band Acoustic Doppler Current Profiler (ADCP) as shown in Figure A3. These instruments use a 1200-kHz operating frequency. The equipment is mounted over the side of a boat with the acoustic transducers submerged and data is collected while the vessel is underway as shown in Figure A4. The Broad-band, ADCP transmits acoustic pulses from four transducers into the water column. Particles carried by the water currents scatter the sound back to the broad band, which listens for the echo. The ADCP assigns depths and velocity to the received signal based on the change in the frequency caused by the moving particles. This change in frequency is referred to as a Doppler shift, and the ADCP can measure the velocity at up to 128 depths in the water column. The ADCP is also capable of measuring vessel direction, current direction, water temperature, and bottom depth. Communication with the instrument for setup and data recording is performed with a portable computer using manufacturer-supplied software, hardware, and communication cables. The manufacturer-stated accuracies for current speed measurement are ±0.2 cm/sec; for vessel direction ±2 deg; and temperature ±5 °F.

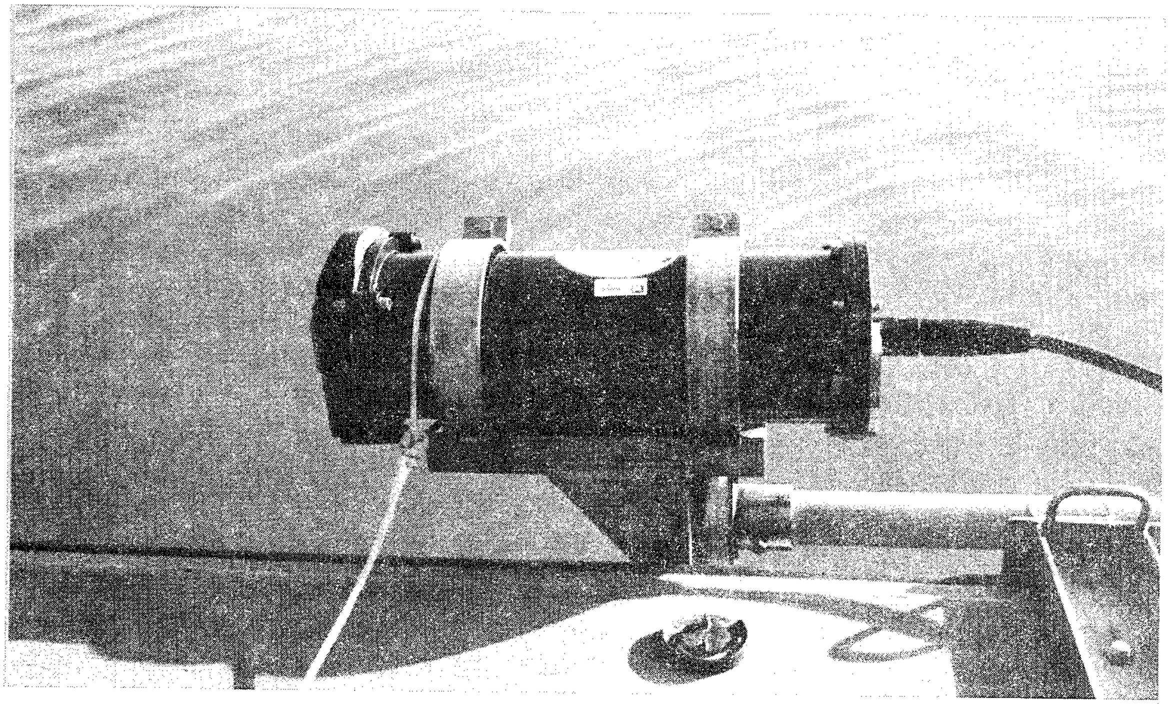


Figure A3. Acoustic Doppler Current Profiler (ADCP)

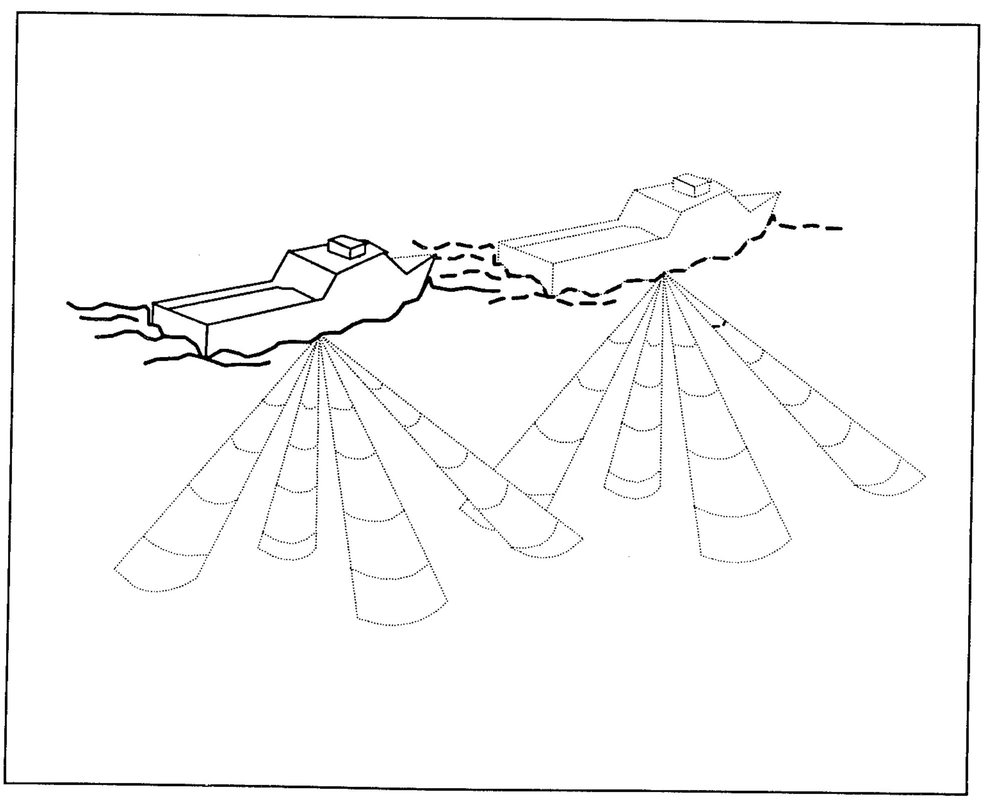


Figure A4. Vessel Mounted ADCOP

Suspended Sediment Samples

In combination with the over-the-side velocity measuring equipment, water samples for analyses of salinities and total suspended solids are obtained by pumping the sample from the desired depth to the surface collection point. The pumping system consists of a 1/4-in.-ID plastic tubing attached to the current meter signal cables for support. The opening of the sampling tubing is attached to the solid suspension bar at the same elevation as the current meter and is pointed into the flow. A 12-V d-c pump is used to pump the water through 50 ft of the tubing to the deck of the boat where each sample is then collected in individual 8-oz plastic bottles. The pump and tubing are flushed for approximately 1 min at each depth before collecting the sample.

Water Level Measurements

Water level elevations, temperature, conductivity, and salinity measurements, are recorded using ENDECO models 1152 and 1029 (water level and temperature only) solid-state measurement (SSM) water level recorders shown in Figure A5. The ENDECO model 1152 SSM and 1029 SSM recorders

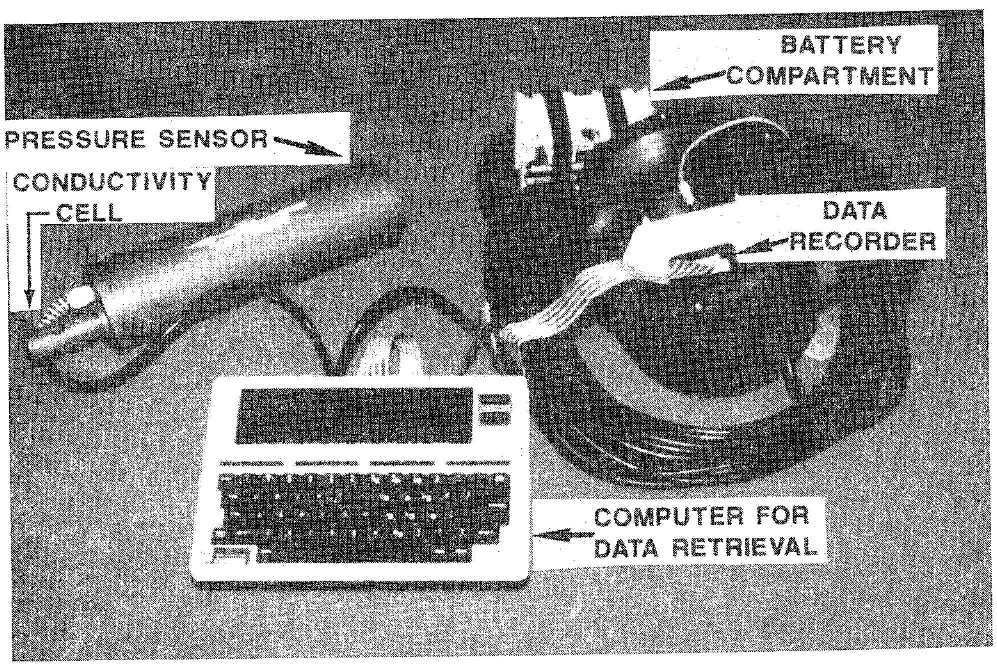


Figure A5. Water level recorder

contain a strain gage type pressure transducer located in a subsurface case that records the absolute pressure of the column of water above the case. The pressure transducer is vented to the atmosphere by a small tube in the signal cable to compensate for atmospheric pressure. The pressure is measured for 49 sec of each min of the recording interval with a frequency of 5-55 kHz to

filter out surface waves, therefore eliminating the need for a stilling well. The accuracy is ±0.05 ft. The sampling time interval can be set from 1 min to 1 hr. The 1152 SSM and 1029 SSM also measure temperatures using a thermilinear thermistor built into the recorders. The thermistor has a range of -5 °C to +45 °C, with an accuracy of ±0.2 °C. The 1152 SSM measures conductivity by an inductively coupled probe installed on the meter. These measurements and the measurements of temperature are used to calculate water salinity in units of parts per thousand (ppt) with an accuracy of ±0.2 ppt.

The sampling time interval for conductivity and temperature cannot be set independently from the water level measurements. The data from each recorder are stored on a removable EPROM solid-state memory cartridge located in a waterproof surface unit that also contains the DC power supply.

Salinity Measurements

The Hydrolab Datasonde 3 Water Quality Data Logger, shown in Figure A6, provides conductivity and temperature with a computed salinity measurement corrected to a known calibration standard at 25 °C. The recorder housing is a high-density PVC case with a specific conductance cell and temperature sensor. The specific conductance probe is a 6 electrode cell having a measurement range of 0.0 to 100 mS/cm and accuracy of ±1 mS/cm. The salinity range is from 0.0 to 40 ppt with an accuracy of ±0.2 ppt (calculated from the conductivity). The temperature probe is a thermistor type sensor with a measurement range of -5 to 50 °C and accuracy of ±0.15 °C. The data sampling intervals range from 1-59 sec, 1-59 min, or 1-23 hr. Data are stored on non-volatile EPROM chips. Internal or external batteries provide the power requirements for sensor operation and data storage. Data are offloaded from the instrument via an industry standard RS-232 port to a personal or laptop computer using standard communication software.

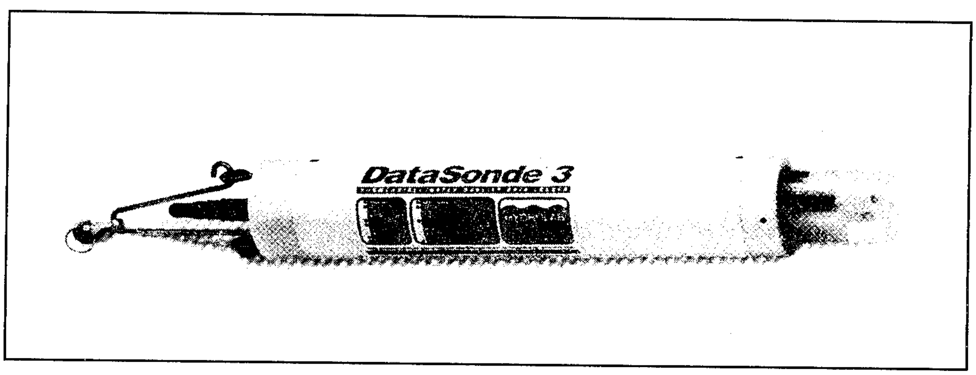


Figure A6. Hydrolab water quality data logger

Laboratory Equipment and Sample Analysis

Laboratory analysis for salinities

An AGE Instruments Incorporated Model 2100 MINISAL salinometer (Figure A7) with automatic temperature compensation is used for the determination of salinity concentrations in the individual samples. The salinometer is a fully automated system, calibrated with standard seawater, and the stated manufacturer's accuracy is ± 0.003 ppt on samples ranging from 2 to 42 ppt.

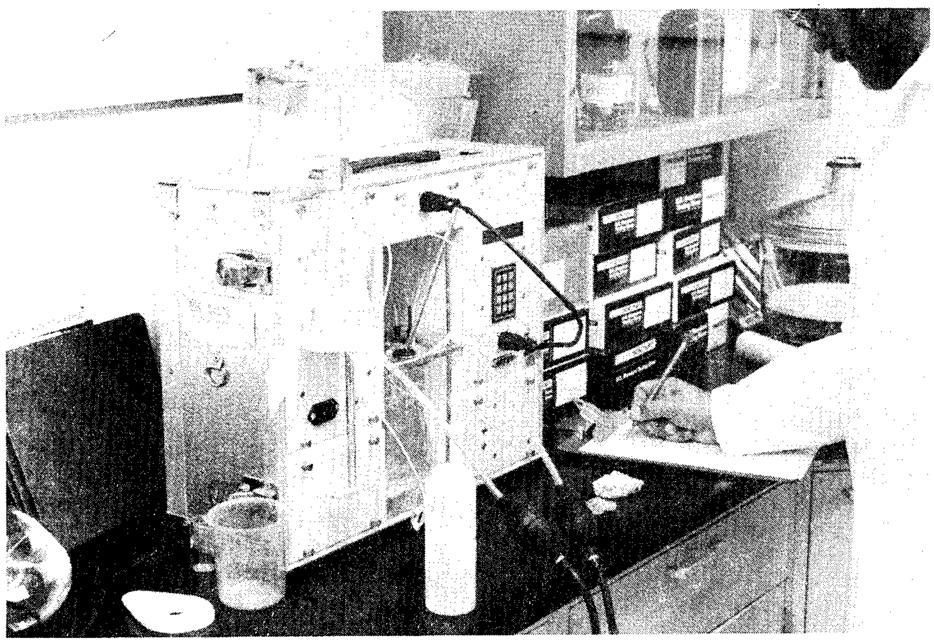


Figure A7. AGE MINISAL salinometer

Laboratory analysis for total suspended materials

Total suspended materials (TSM) are determined by filtration of samples. Nuclepore polycarbonate filters with 0.40 micron pore size are used. They are desiccated and preweighed, then a vacuum system (8-lb vacuum maximum) is used to draw the sample through the filter. After the filters and holders are washed with distilled water, the filters are dried at 105 °C for 1 hr and reweighed. The TSM are calculated based on the weight of the filter and the volume of the filtered sample.

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13. ABSTRACT *(Maximum 200 words)*

Water levels, current speed, current direction, salinity, temperature, and suspended sediment samples were obtained in the Cape Fear River estuary from mid-August 1993 through mid-October 1993. The data were collected using long-term (45-60 days) moored equipment and short-term (two tidal cycles) boat-mounted measuring and sampling equipment. The data were collected to provide synoptic information on the hydrodynamics of the estuary for use in the verification of numerical models. This report describes the equipment and procedures used in the data collection effort and presents tables and plots of the data.

14. SUBJECT TERMS

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